Next-Lab

Next Generation Stakeholders and Next Level Ecosystem for Collaborative Science Education with Online Labs

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Work package 1 – Outreach and Impact

D1.2 Curriculum analysis & teacher organisations training needs for primary and secondary education

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1	University Twente	UT	The Netherlands
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3	IMC Information Multimedia Communication AG	IMC	Germany
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Legal Notices

Executive summary

According to the Description of Work (DoW) the aim of Task 1.6 Lining up with National curricula is to run a curriculum analysis for both primary and secondary schools.

For primary schools, the outcomes of the curriculum analysis will support the development of learning spaces targeting primary teachers. More opportunities for Next-Lab to enter the respective primary education curricula in Europe will also be identified in terms of secondary education, aiming to provide European Schoolnet's Ministries of Education STEM Representatives working group with concrete recommendations that will have the potential to be transformed into actions on national level.

In chapter 2 focus is given on the methodology that has been put together in order to run this exercise, along with information related to the sources of information that have been used, the age ranges that the curriculum analysis focused on and the analytical process that has been followed.

In chapter 3 and 4 respectively, a short summary of the educational systems per country, including the subjects that were of interest to the curriculum analysis are provided.

Chapter 5 presents the outcomes of the development of the Big Ideas as developed in Go-Lab while chapter 6, presents the curriculum analysis results for both primary and secondary education including their connection to the Big Ideas of Science.

Chapter 7 focuses on Teacher Organisations' training needs for primary and secondary education, as they have been identified throughout the work that has been done for Task 1.1.

Finally, the Annex presents extensive information on the curriculum analysis subjects that have been used for the respective country and level of education offering insights and details on the topics of common interest.

Table of Contents

1. Introduction

The aim of “Lining up with national curricula” task (T1.6) was to carry out a detailed curriculum analysis in a selected group of countries where Next-Lab is currently and will continue to be implemented. The outcomes will help the Next-Lab team identify a set of common core topics for which labs and ILSs will be developed. Based on this information, a detailed development and implementation plan will be put into place and carried out in the course of the project.

The curricula analysed corresponded to primary and compulsory secondary education level, that is to say, in most cases for ages between 6 to 18 years old. Particular effort has been made in presenting and taking into account the particularities of each country and the curriculum developments on national level, aiming to provide as accurate and up to date information as possible.

2. Curriculum analysis

2.1 Selection of countries

A comprehensive curriculum analysis has been performed from a representative sample of 11 countries that included:

1. Belgium
2. Cyprus
3. Estonia
4. Germany
5. Greece
6. Portugal
7. Finland
8. France
9. The Netherlands
10. UK-England
11. Spain

For Germany, the North Rhine-Westphalia state, its most populated state (Länder), was chosen to mainly represent the country. The North-Rhine-Westphalia state curriculum is also the same to the ones of three more Landers and is considered quite representative[1] of all 16 Landers. At the same time and in order to ensure a complete representation of the entire Germany, special effort is being made to consult and reflect in the curriculum analysis the situation in the remaining 15 states.

The sample of countries was chosen based on three main factors that are explained below:

- The **countries of provenance of WP1 partners**: Preference was given to countries of the Next-Lab members of the consortium participating into the work of WP1. This choice facilitated the collection of the most recent curricula information of the respective countries and the validation of the curriculum analysis results when needed. Spain has also been added to the analysis after the request of the Spanish TTI.
- To ensure a fair representation of Europe, focus was given on countries that geographically represent north, south, east and west Europe
- The case of Germany: With the highest population among the EU member states (16, 25 % of the EU27 population, Eurostat 2013) the integration possibilities of Go-Lab to the national curriculum, is of great importance. However, as Germany is composed by 16 states (Länder) each one deciding its own educational policies, diverse curricula can be found across the country. In this report, North Rhine-Westphalia, the largest state in terms of population, serves as an example in cases where the specificity of particular topics makes it impossible to give a universal description for all states, given the federated nature of educational policy and practice in Germany. When it comes to secondary education focus will be placed on

[1] http://www.schulentwicklung.nrw.de/lehrplaene/upload/klp_gs/LP_GS_2008.pdf

Gymnasium (one of the six available types of school options), the secondary school which prepares students to access higher education.

2.2 Collection of latest curricula information

In the last 4 years, curricula reforms have taken place in many European countries. Consequently, and before proceeding with the actual analysis, it was essential to ensure that access to the most current and up to date information was available. Next-Lab partners along with resources provided through EUN's Ministries of Education STEM representatives working group are currently the main sources of information. The TIMMS report 2015[2] on students' science achievement has also been used.

The main sources of information that have been used regarding then national curricula can be found below:

Country	Curricula info (primary, secondary)
Belgium	http://onderwijs.vlaanderen.be/nl/directies-en-administraties-basisonderwijs (primary) http://ebl.vlaanderen.be/publications/documents/36473 (primary) http://www.ond.vlaanderen.be/curriculum/secundair-onderwijs/index.htm (secondary)
Cyprus	Maths program (primary): http://www.schools.ac.cy/klimakio/Themata/Mathimatika/analytiko_programma.html Environmental education (primary) : http://www.schools.ac.cy/klimakio/Themata/perivallontiki_ekpaidefsi/analytiko_programma.html Design and technology (primary) http://www.schools.ac.cy/klimakio/Themata/schediasmos_technologia/analytiko_programma.html Extra information http://timssandpirls.bc.edu/timss2015/encyclopedia/countries/cyprus/the-mathematics-curriculum-in-primary-and-lower-secondary-grades/ http://nop.moec.gov.cy/index.php/mathimata/mathimata-a-lykeiou (secondary) http://nop.moec.gov.cy/index.php/mathimata/mathimata-b-c-lykeiou (secondary)
Estonia	https://www.hm.ee/en/national-curricula-2014 (basic & secondary schools)
Germany	http://timssandpirls.bc.edu/timss2015/encyclopedia/countries/germany/the-science-curriculum-in-primary-and-lower-secondary-grades/
Greece	http://www.minedu.gov.gr/dimotiko-2/didaktea-yli-dimot (primary) http://www.minedu.gov.gr/gymnasio-m-2/didaktea-yli-gymn (secondary) http://www.minedu.gov.gr/lykeio-2/didaktea-exet-yli-lyk (secondary) http://www.pi-schools.gr/ (secondary)
Portugal	1st cycle: 1st - 4th grade: http://www.dge.mec.pt/programas-1o-ciclo 2nd Cycle: 5th - 6th grade: http://www.dge.mec.pt/programas-2o-ciclo 3rd cycle: 7th to 9th grade: (it is mixed with the previous in many subject domains: http://www.dge.mec.pt/programas-e-metas-curriculares-0 Secondary: http://www.dge.mec.pt/programas-e-metas-curriculares
Finland	http://oph.fi/english/curricula_and_qualifications/general_upper_secondary_education

[2] http://timss2015.org/timss-2015/science/student-achievement/

France	http://www.education.gouv.fr/pid24307/les-programmes-de-l-ecole-elementaire.html (primary) http://www.education.gouv.fr/pid24239/les-programmes-du-lycee.html (secondary)
The Netherlands	Secondary education (complete overview in Dutch): http://leerplaninbeeld.slo.nl Primary education (complete overview in Dutch): http://tule.slo.nl Primary education (short overview in English): http://www.slo.nl/primair/kerndoelen/Kerndoelen_English_version.doc
UK-England	https://www.gov.uk/government/publications/national-curriculum-in-england-primary-curriculum (primary) https://www.gov.uk/government/publications/national-curriculum-in-england-secondary-curriculum (secondary) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/381754/SECONDARY_national_curriculum.pdf (secondary)
Spain	http://timssandpirls.bc.edu/timss2015/encyclopedia/countries/spain/ (primary & secondary)

2.3 Primary & secondary education age ranges per country

One of the aspects that contribute to the complexity of the curriculum analysis exercise is the differences in schooling ages that are visible all around Europe. With this in mind and before proceeding to the actual analysis of the curricula for each one of the selected countries and subjects, it is important to take into account how the different educational systems are organised and how the ages of pupils attending primary and secondary education vary.

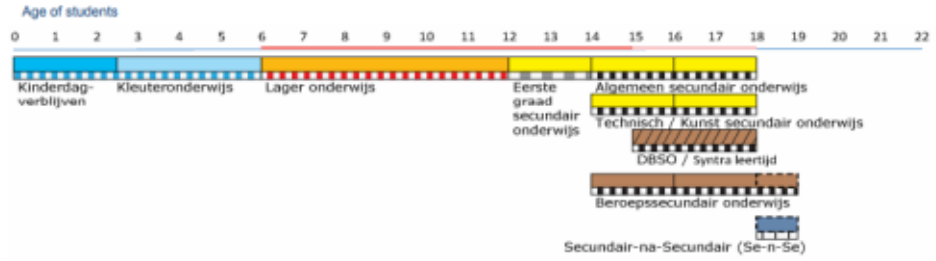
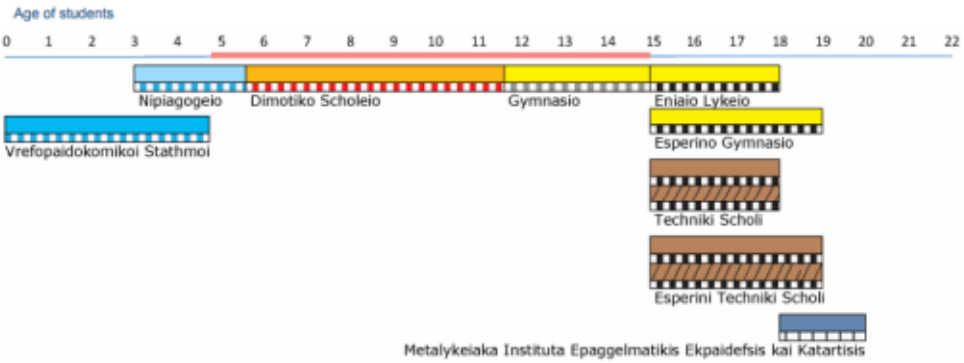
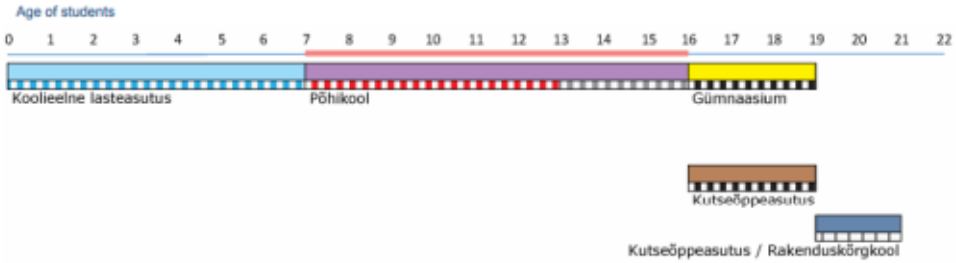
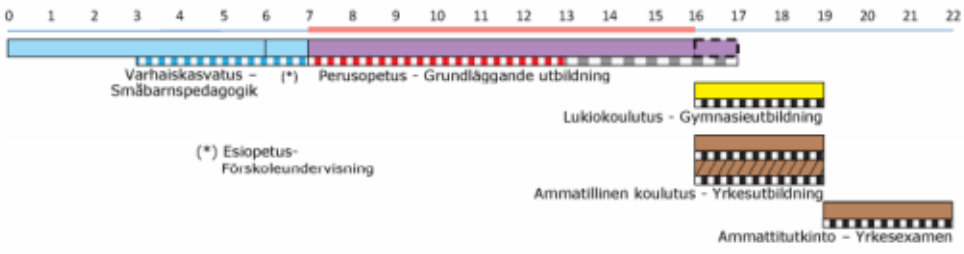
The information provided in ***"The Structure of the European Education Systems 2016/17: Schematic diagrams"***[3] report published by Eurydice provides us with a clear view of the situation per country.

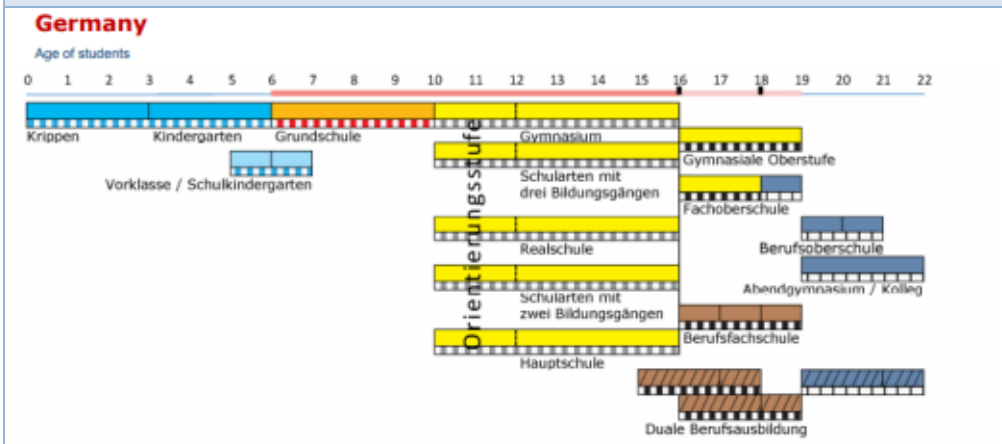
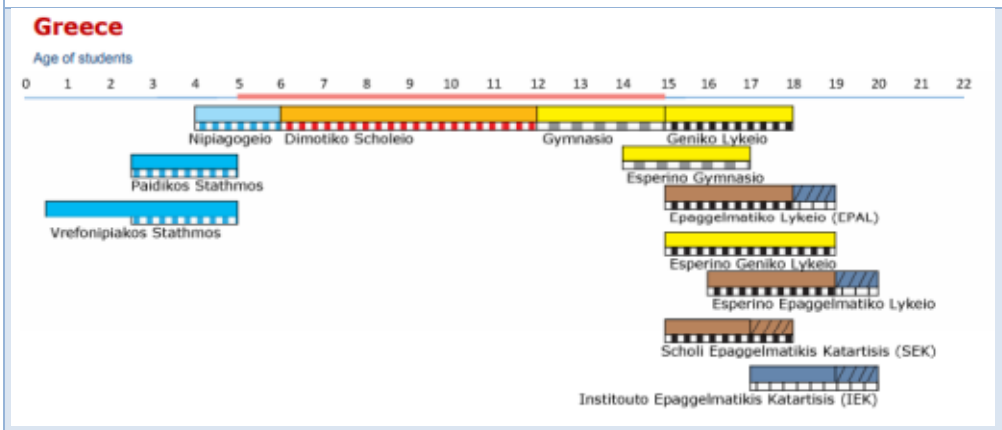
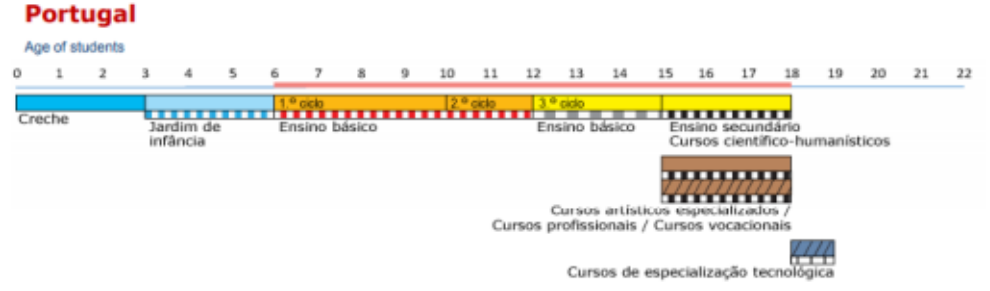
Although for the purpose of our curriculum analysis focus is given only to primary and secondary education, a full index for the diagrams in Table 1 is provided in Figure 1.

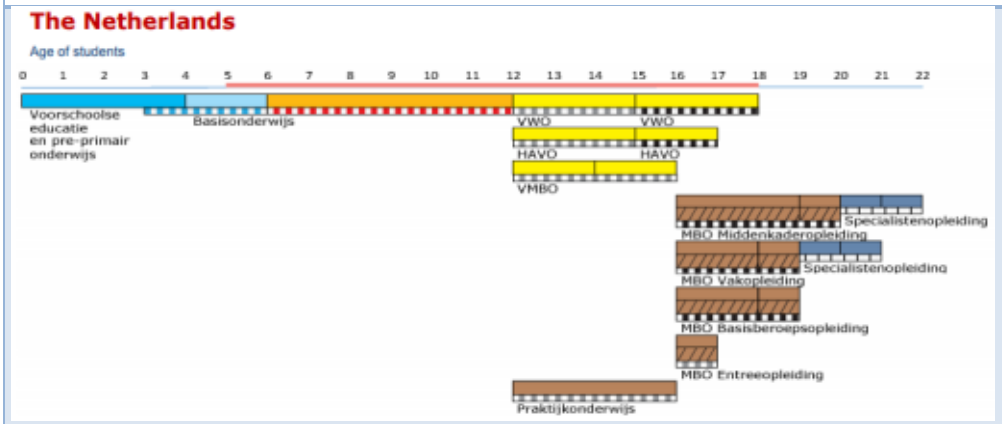
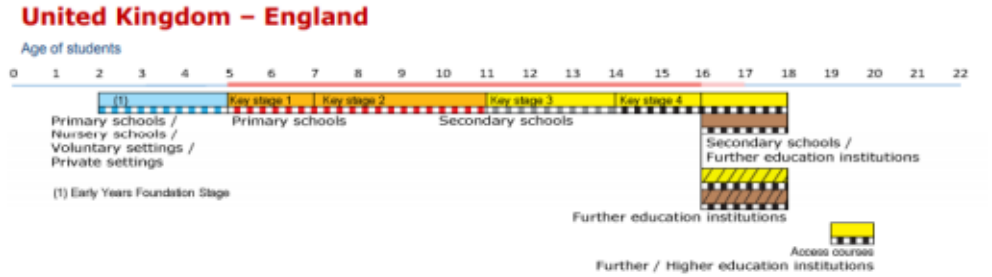
Figure 1: Index for respective countries' educational systems diagrams

[3] https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/images/9/9d/Structure_of_education_systems_2016_17.pdf

Table 1: Diagrams of educational levels vs age of students per country

Country *(source Eurydice)*	Primary - ages	Secondary – ages
Belgium – Flemish Community 	6-12	12-18
Cyprus 	5,5-11,5	11,5-19
Estonia 	7-16	16-19
Finland 	7-16	16-19

Country *(source Eurydice)*	Primary - ages	Secondary – ages
	6-11	11-18
	6-10	10-19
	6-12	12-19
	6-12	12-18

Country *(source Eurydice)*	Primary - ages	Secondary – ages
	5-12	12-20
	5-11	11-18

A close look at these diagrams reveals that in the majority of countries the entry point to compulsory **primary education** is between **5-6 years**. The only exception is that of Finland and Estonia where pupils are starting primary education a bit later, at the age of 7 years.

In **secondary education,** the age of **11-12 years** is shared, as entry point, among the majority of countries. The only exceptions in this case are again in Finland and Estonia where compulsory education is organised in a single structure. This means that education in these countries is provided from the beginning to the end of compulsory schooling, with no transition between primary and lower secondary education and with general education provided in common for all pupils. In these two countries, the entry point to secondary education is at 16 years.

For the purpose of the curriculum analysis and in order to facilitate the communication and organisation of the results, the following assumptions, shown in Table 2, will be used.

Table 2: Level of education vs Pupils age range (to be used for Next-Lab curriculum analysis)

Country (-ies)	Primary education – age range	Secondary education – age range
Belgium, Cyprus, France, Germany, Greece, Portugal, the Netherlands, UK- England	5 - 12	12-19
Estonia, Finland	7- 16	16-20

To address this and in order to ensure the readability and usability of the produced curriculum analysis results, age ranges will be used in the presentation of the outcomes of this exercise, in chapter 6.

2.4 Subjects of interest in Primary and Secondary education

Looking across the primary and secondary curricula of the respective countries and taking into account Next-Lab focus on STEM education, we have determined the main set of subjects that are of interest to the project.

In primary education, all countries include in their programmes Mathematics while Nature, Natural Sciences, and Environmental Sciences usually either appear as standalone or combined subjects i.e. Nature and Technology in The Netherlands. In some countries, Geography is part of the curriculum as a separate subject while in the cases of Finland and Estonia and due to the different age ranges, please see section 2.3, Physics and Chemistry are also available on primary level.

An overview of the main subjects of interest for the curriculum analysis can be found in

Table 3 below.

Table 3: Country vs Primary education STEM related subjects

Country (-ies) Subject(s)	Mathematics	Nature, Natural Sciences	Geography	Physics	Chemistry
Belgium, Cyprus, France, Germany, Greece, Portugal, the Netherlands, UK-England	x	x	x	-	-
Estonia, Finland	x	x	x	X	x

In secondary education, we have a more extended set of subjects, which can be seen in Table 4

Table 4: Country vs Secondary education STEM related subjects

Country (-ies)	Sciences (Mathematics, Geometry)	Biology	Geography	Physics	Chemistry	Technology	Informatics
Belgium, Cyprus, France, Germany, Greece, Portugal, the Netherlands, UK-England	X	X	X	x	X	x	x (Cyprus, Greece only)
Estonia, Finland	X	X	X	x	X	x	n/a

2.5 Process

2.5.1 First phase

Taking into account the observations made in sections 2.3 and 2.4 regarding the age ranges in primary and secondary education in the countries of interest plus the subjects the curriculum analysis will be focusing on, a plan of action has been composed. As a first step, a complete data collection and analysis for *primary and secondary education* has been completed for the following countries.

- Belgium
- Cyprus
- Greece
- France
- Germany
- Portugal
- The Netherlands

- UK

During this step, preliminary results of the curriculum analysis have been composed and shared with the Next-Lab consortium in order to provide some initial indications on the upcoming topics of interest that will drive the development of new labs and ILSs for the rest of the project.

2.5.2 Second phase

In the second phase, a complete curriculum analysis has been carried out for Estonia and Finland. These two countries share some similarities in terms of age ranges, such as later start of obligatory education and structure. Once these results were available, they were incorporated into the curriculum analysis results of the initial 8 countries and have been organised in a homogeneous output which also took into account the age range dimension. Finally, the analysis of the Spanish curriculum has also taken place and results have been incorporated to the ones developed at the beginning of this phase.

Lastly, the Big Ideas of Sciences have been introduced. The complete curriculum analysis results have been mapped in relation to them and helped us reach conclusions in terms of the popularity and use of specific ideas, the lack of others etc.

3. Primary education curriculum analysis

3.1 Belgium (Flemish Community)

In Belgium, each of the three Communities (Brussels-Capital, Flanders and Wallonia) are responsible for most education competences[4]. Particularly, in Flanders, the Ministry of Education and Training is in charge of all stages of education and training.

All children residing in Belgium are introduced to compulsory education, which lasts from the ages of 6 until 18 years old. A pupil must attend full-time compulsory education until the age of 15. From 15 onwards, students can engage in part-time schooling and choose a structured learning path, combining part-time vocational education in an educational institution with part-time employment.

Elementary education (basisonderwijs) comprises both pre-school education (kleuteronderwijs) and primary education (lager onderwijs). Primary education is targeted at children from 6 to 12 years old and comprises six school years.[5] The common core curriculum for primary education consists of areas of learning and cross-curricular themes. Next-Lab subjects of interest are the following:

a. World orientation, which covers nature, technique, humankind, society, time and space, use of resources. From 1 September 2015 onwards 'world studies' are subdivided in 'science and technique' and 'human and society' and
b. Mathematics, which cover numbers, measuring, geometry, strategies and problem-solving skills, attitudes.

ICT is very much used in the majority of schools and should be noticed as a cross curricular theme which is put into use in all areas.

A complete account of the Next-Lab related topics can be found in the Annex section 9.1.1.

3.2 Cyprus

In Cyprus, compulsory education covers the ages between 4 years and 8 months and 15 years of age. More precisely, primary education is provided for children ages 5 years and 8 months to 11 years and 8 months. The National Curriculum and the teaching methodologies adopted in Cypriot primary education emphasize learning processes and focus on strategies to assist pupils to develop their critical and creative thinking.

The cornerstone of primary education objectives has always been a balanced development of children's personality and knowledge, and the development of appropriate attitudes and skills. In particular, it aims to organize, ensure and offer to all children learning opportunities that will allow them to:

a. Achieve a balanced cognitive, emotional and psychomotor development while taking full advantage of the means offered by modern technology.
b. Successfully resolve the various problems they could potentially face and the possible difficulties they might find in adapting to their school and wider environment.
c. Develop positive attitudes towards learning.

[4] Three exceptions remain at federal level. Those are the determination of the beginning and the end of compulsory education; the minimum requirements for the issuing of diplomas and the regulation of retirement for employees in the educational system.

[5] https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Belgium-Flemish-Community:Overview

d. Develop social understanding, resiliency, belief in humanitarian values, respect for cultural heritage and human rights.

e. Appreciate and develop a disposition for creativity and love towards life and nature, to become effectively sensitized towards issues of environmental sustainability and environmental improvement.[6]

The highlighted subjects in the Cypriot curriculum in relation to Next-Lab are the following: Health education, geography, mathematics, environmental education, design, technology, and natural sciences.

A complete account of the Next-Lab related topics can be found in the Annex section 9.1.2.

3.3 Estonia

General education in Estonia is divided in pre-school, basic and upper-secondary education. Basic education (the equivalent to primary education) is the minimum required and it can be acquired partially in primary schools (grades 1 to 6), basic schools (grades 1 to 9) or upper secondary schools that also teach basic school curricula.

Basic school is divided in three stages: stage I (covering grades 1 to 3); stage II (covering grades 4 to 6) and stage III (covering grades 7 to 9) and two types of curricula are available: national curriculum of basic school and simplified curriculum for basic school.

The school curriculum is developed through the Basic Schools and Upper Secondary Schools Act. This defines the national curriculum of basic school (thus, national curriculum) and establishes a state standard of basic education. Learning outcomes achieved at completion of basic school education are in line with the general requirements described in Level 2 of the Estonian Qualifications Framework[7].

The subject areas and the syllabuses of compulsory subjects that are described therein are:

1. Language and literature: Estonian, literature (in an Estonian language school), Russian language, literature (in Russian-medium schools);
2. Foreign languages: A-foreign language, B-foreign language and Estonian as a second language;
3. Mathematics: Mathematics;
4. Natural resources: natural science, biology, geography, physics, chemistry;
5. Social sciences: human studies, history, social studies;
6. Arts subjects: music, art;
7. Technology: work instruction, crafts and homework, technology education;
8. Physical education: Physical education.[8]

Elective subjects are:

1. Religious studies;
2. informatics;
3. career counselling;

[6] http://www.moec.gov.cy/dde/en/structure_dpt_primary_ed.html

[7] Estonian Qualification Framework: https://www.hm.ee/en/activities/qualifications/qualifications-framework

[8] https://www.hm.ee/en/activities/qualifications/qualifications-framework

4. entrepreneurship education.

A complete account of the Next-Lab related topics can be found in the Annex section 9.1.3

3.4 Germany

In the Federal Republic of Germany, responsibility for the education system is divided between the Federation (central government) and the Länder (regions) and its scope defined in the Basic Law (*Grundgesetz*). Unless the mentioned law grants legislative powers to the Federation, the Länder hold the right to legislate in the school and the higher education sector, in adult and in continuing education. The Basic Law also provides for particular forms of cooperation between the Federation and the Länder within the scope of joint tasks (*Gemeinschaftsaufgaben*).

General compulsory school (in the form of full-time schooling) lasts nine years and starts the year in which students reach six years old. Those who do not attend a full-time general education school or a vocational school at upper secondary level once they have completed their period of compulsory general schooling must still attend part-time schooling (compulsory Berufsschule attendance – Berufsschulpflicht), which normally lasts three years.

In terms of curriculum, primary mathematics education is regulated across the 16 German states by 13 different curricula, determined by the German national educational standards. Although 12 states have passed their own curricula, 4 of those (Berlin, Brandenburg, Bremen, and Mecklenburg-Western Pomerania) have collaborated in formulating a common core curriculum. On the other hand, primary science education is currently regulated by 14 curricula. In contrast to mathematics, this is not determined by the national educational standards[9].

A complete account of the Next-Lab related topics can be found in the Annex section 9.1.4

3.5 Greece

In Greece, the administration of primary and secondary education is conducted at central, regional and local level respectively by: the Ministry of Education, Research and Religious Affairs; the Regional Education Directorates; the Directorates of Education (Prefectures) and the School Units. However, the Ministry of Education, Research and Religious Affairs holds supervisory control over primary and secondary schools by defining the content of the curricula, recruiting and appointing staff and controlling funding.

The Greek educational system is mainly divided in three different levels: primary, secondary and tertiary, with an additional post-secondary level providing vocational training. Compulsory education in Greece lasts for ten years, from 5 to 15. Within this, primary education is divided into pre-primary school and primary school, lasting six years (ages 6 to 12). Pre-primary education starts at 4 years old and attendance is compulsory for all 5-year-old children. Primary Education comprises lasts 6 years and concerns children between the ages of 6 to 12 years.

The basic subjects in primary education are the following:

- Modern Greek Language
- Mathematics
- Environmental Studies

[9] http://timssandpirls.bc.edu/timss2015/encyclopedia/countries/germany/the-science-curriculum-in-primary-and-lower-secondary-grades/

- Physical Education
- Music
- Art
- Theatre
- Flexible Zone
- English

Additional Subjects are the following:

- Physics
- Geography
- History
- Religion
- Social and Political Studies
- Second Foreign Language[10]

In grades 1 to 4, the subjects of mathematics and environmental studies are mostly related to Next-Lab. In grades 5-6 physics and geography are also added. A complete account of the Next-Lab related topics can be found in the Annex section 9.1.5.

3.6 Portugal

In Portugal, the Ministry of Education is responsible for the development of general education. The education system is divided in pre-school education (until pupils begin basic education), basic education (6 to 15 years old) and secondary education (15 to 18 years old). The second stage of basic education lasts for nine years and is divided into three cycles. Each of these is aimed at completing and building up on the previous one:

Cycle 1 and 2 comprise the whole primary education period. In particular:

- The first cycle corresponds to years 1 to 4 of schooling;
- The second cycle corresponds to years 5 and 6 of schooling;
- The third cycle corresponds to lower secondary education and lasts for three years.

Throughout basic education (apart from the provision of general basic education), pupils can choose specialized artistic courses in the areas of music and dance. Following are the main subjects, classified by cycles:

[10] https://en.wikipedia.org/wiki/Education_in_Greece#Primary_education

First Cycle (Year 1 to 4)

General subjects:

- Portuguese Language
- Environment Study
- Mathematics

Enrichment Activities:

- English Language
- Artistic Education
- Physical Education
- Music Education

Facultative:

- Catholic (or other confessions) Moral and Religious Education

Second cycle (Year 5 and 6)

- Portuguese Language
- Mathematics
- History and Geography of Portugal
- English (levels 1 and 2)
- Natural Sciences
- Visual Education (Visual arts)
- Technological Education (Crafts)
- Physical Education
- Music Education
- Catholic (or other confessions) Moral and Religious Education (facultative)

Third cycle (Year 7 to 9)

- Portuguese Language
- Mathematics
- English (levels 3, 4 and 5)
- 2nd Foreign language - French, Spanish or German (levels 1, 2 and 3)
- Natural Sciences
- Physics and Chemistry
- History
- Geography
- Physical Education
- Visual Education (Visual arts)*
- Technological Education (Crafts)*
- Drama/Music*
- Computer and IT / an alternative of the school (only in 7th and 8th years)
- Catholic (or other confessions) Moral and Religious Education (facultative)

(*) In year 9, students have to choose between Visual Education, Technological Education, Music and Drama, according to the school's availability.

Basic education can also be completed through different paths (adapted to the profile/characteristics of the students). As it follows:

- Education and Training Courses;
- Alternative Curricular Pathways;
- Integrated Education and Training Programme.[11]

A complete account of the Next-Lab related topics can be found in the Annex section 9.1.6.

3.7 Finland

In Finland, local autonomy in education is extensive. Local authorities (municipalities) provide most of pre-primary, primary and upper secondary education in Finland. Individual schools and teachers have a lot of freedom in designing their own curricula and general instructions. However, at national level, the Ministry of Education and Culture is responsible for education. In addition, the Finnish National Board of Education works with the Ministry to develop educational aims, content and methods for primary, upper secondary and adult education.

The compulsory educational system consists of a nine-year comprehensive school, with pupils aged from 7 to 16 years old, attending Finnishperuskoulu (Swedish basic schools) in which attendance is mandatory. In particular, it is divided in 6-year primary schools (alakoulu or ala-aste) followed by comprehensive 3-year middle schools, (yläkoulu or yläaste).[12]

While education in Finland is very much dependent on local authorities, there is a common curriculum. Its main purpose is to promote the continuous improvement of education quality and to reinforce the continuum of education. It lays the foundation for the pupils' transition between educational stages. In its preparation, other local plans will be accounted for, including

- a possible curriculum for early childhood education and care
- a curriculum for pre-primary education;
- a possible curriculum for instruction preparing for basic education;
- a possible plan for morning and afternoon activities;
- a plan for the well-being of children and young people referred to in the Child Welfare.

A complete account of the Next-Lab related topics can be found in the Annex section 9.1.7

3.8 France

The French education system is characterised by a strong central state presence in the organisation and the funding of Education, as it is regulated by the Department for National Education, Higher Education and Research.

Primary education is provided in primary schools for children between the ages of 6 and 11 and it marks the start of compulsory schooling. Primary schooling consists of five years of education. These five years are divided over two main cycles of learning. The first three

[11] https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Portugal:Overview

[12] https://en.wikipedia.org/wiki/Education_in_Finland

years in primary school are called the cycle *apprendissages fondamentaux,* where the emphasis is put on basic skills such as reading, writing and arithmetic. The next two years form what is known as the cycle de consolidation. The main subjects of interest during these years are Mathematics, Discovering the world, Science and Technology, Geology. At the end of this cycle, pupils automatically access secondary education.[13]

All subjects including their specific topics can be found in Annex section 9.1.8.

3.9 Spain

Primary education in Spain comprises six academic courses, with students between 6 and 12 years of age. It is organized into several areas, all of which have a global and integrating character. The subjects in primary education are grouped in three blocks of (1) core subjects, (2) specific subjects, and (3) subjects of free configuration, over which the Spanish Government, the Ministry of Education and the rest of Educational Administrations (including educational centres) will perform their functions. The distribution of subjects is organized as it follows:

- The block of core subjects is supposed to guarantee the knowledge and skills that allow students to acquire a solid education. Those comprise Nature Sciences; Social Sciences; Spanish Language and Literature; Mathematics and First Foreign Language.
- The block of specific subjects allows more autonomy in terms of scheduling and of subject content. Students must study the following areas of the specific subject block in each of the courses:
  - Physical Education.
  - Religion or Social and Civic Values (discretion of parents/legal guardians)
  - Depending on the regulation of each Administration and/or the offer of the teaching centres, at least one of the following subjects: Art Education; Second Foreign Language; Religion (if not previously chosen) and social and Civic Values (if not previously chosen).
- The block of "subjects of free configuration" supposes the greatest level of autonomy, in which the educational Administrations can offer subjects of its own design, including extensions of the core or specific subjects mentioned previously. This distribution does not follows the distribution of competences between the State and the Autonomous Communities.

All subjects including their specific topics can be found in Annex section 9.1.11.

3.10 The Netherlands

In the Netherlands, pupils between 5 and 16 years, pupils must attend school, as the Compulsory Education Act stipulates it. However, in fact, nearly all children attend primary school from the age of four. Primary education covers: Mainstream primary education (BAO); Special schools for primary education (SBAO) and Special schools catering for both the primary age group (SO and VSO).

Mainstream primary education lasts 8 years and is addressed to children aged from 4-5 years old to 12. All children must make an attainment test in level 8 of primary school.

[13] https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/France:Overview

Through this test, pupils are given advice on which secondary school better fits their level, based on their learning achievements.

In terms of attainment targets, the law sets primary education attainment targets for each compulsory subject. They indicate what children should know and what they should be able to do by the end of primary school. The attainment targets only apply to compulsory subjects, which are the following:

- Dutch;
- English;
- arithmetic and mathematics;
- social and environmental studies (including geography, history, biology, citizenship, road safety and political studies);
- creative expression (including music, drawing and handicrafts);
- sport and movement;

Frisian is also a compulsory subject for primary schools in the province of Friesland. Schools may apply to the provincial executive for exemption if less than 5% of pupils at the school have a Frisian background. As extra subjects, schools can choose to teach extra subjects in addition to the compulsory core curriculum, such as religious education, French or German.[14]

In the Netherlands, primary education curriculum, the subject of ***"Personal and world orientation"*** is the more suitable for providing Go-Lab with input on possible topics to cover. In this learning area, pupils orientate on themselves, on how people relate to each other, how they solve problems, and how they give meaning to their existence. Pupils orientate on their natural environment and the phenomena occurring in it. Orientation on nature includes animals, plants, natural phenomena, and ourselves. Orientation on the world includes the creation of a worldview in terms of space and time. The subject of ***"Mathematics/Arithmetic"*** is also interesting for Go-Lab. In it, children will gradually acquire – in the context of situations that are meaningful to them – familiarity with numbers, measurements, forms, structures, and the relationships and calculations that apply to these.

A complete account of the Next-Lab related topics can be found in the Annex section 9.1.9.

3.11 UK

In the UK, schools providing primary education are now known as primary schools. They are generally addressed to children from four to eleven years old. Primary schools are often subdivided into infant schools for children from four to seven and junior schools for ages 7 to 11.

In a few areas there is a "three-tier" system. In this system, children go to lower school or "first school" until about 9, followed by middle school until about 13 and upper school. In areas that adopted a three-tier system, the term primary school is often used as an alternative to First School, taking in ages up to 9 or 10 years old.

In the private sector, fee-paying schools that provide primary education are known as preparatory schools, and they often cater for children up to the age of thirteen. These

[14] https://www.government.nl/topics/primary-education/subjects-and-attainment-targets-in-primary-education

schools are normally designed to prepare pupils for entrance examinations for fee-paying independent schools[15].

The UK has different systems for each region. Available here: https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Countries

Mathematics and Science the subjects of interest for Next-Lab. A complete account of the Next-Lab related topics can be found in the Annex section 9.1.10.

[15] https://en.wikipedia.org/wiki/Primary_education#United_Kingdom

4. Secondary education curriculum analysis

4.1 Belgium (Flemish Community)

When graduating from primary school around the age of 12, students enter secondary education. Here they have to choose a course that they want to follow, depending on their skill level and interests.

Secondary education consists of three cycles (Dutch: graden; French: degrés; German: Grad):

- First stage (year 1 and 2)
- Second stage (year 3 and 4)
- Third stage (year 5 and 6)

The Belgian secondary education grants the pupils more choice as they enter a higher cycle. The first cycle provides a broad general basis, with only a few options to choose from (such as Latin, additional mathematics and technology). This should enable students to orient themselves in the most suitable way towards the many different courses available in the second and third stages. The second and third cycle are much more specific in each of the possible directions. While the youngest pupils may choose at the most two or four hours per week, the oldest pupils have the opportunity to choose between different "menus": like Mathematics and Science, Economics and Languages or Latin and Greek. They are then able to shape the largest part of the time they spend at school. However, some core lessons are compulsory like the first language and sport, etc. This mix between compulsory and optional lessons grouped in menus make it possible to keep class structures even for the oldest students.

The **first stage** in secondary education exists of a general basic programme:

- the A-stream. This stage is not subdivided in various types of secondary education. There is also an offer for pupils who enter secondary education without having obtained the certificate of primary education or for pupils who are less apt at theoretical education
- the B-stream. When successfully finishing the first grade of the B-stream pupils can move to the first grade of the A-stream or they can continue with a pre-vocational second grade.

The **second** and **third stage** offer a choice between four types of secondary education:

- general Secondary Education (gse)
- secondary education in the arts (sea)
- technical Secondary Education (tse)
- vocational Secondary Education (vse)

Gse/sea/tse primarily prepare for moving on to higher education, while vse is aimed at the execution of a profession. In the third stage of vocational education it is possible to comply with compulsory education by means of the alternance training system with a fulltime engagement but only part-time compulsory education.

In this curriculum analysis focus will be given to steams A & B where Next-Lab's main subjects of interest are: Geography, Natural sciences, Technology, Mathematics. In B-stream natural sciences and technology are the same as in A stream. Small differences, usually simplifications, are present in Sciences though.

All subjects including their specific topics can be found in Annex section 9.2.1.

4.2 Cyprus

General Secondary Education in Cyprus is a six-year educational program for students between the ages of 12 and 18. The Upper cycle of the Public Secondary General Education offers a three-year program for older students between the ages of 15 and 18.

It is made up of the Gymnasium (school) (Lower Secondary School), where the main concentration is a general humanistic education. Education is compulsory until the age of 15. From there students attend the Lykeio/Lyceum (Upper Secondary School), a more flexible educational system which offers various specializations depending on the inclinations, skills and interests of the students. Technical and vocational tracks are available.

All subjects including their specific topics can be found in Annex section 9.2.2.

4.3 Estonia

Secondary education in Estonia is based on basic education and divided into general secondary education, provided by upper secondary schools, and vocational secondary education, provided by vocational educational institutions. General secondary education constitutes a set of knowledge, skills and competences, set out in the national curriculum for upper secondary schools, the acquiring of which is the precondition for further studies at universities and vocational educational institutions. Upper secondary education is not mandatory.

General secondary education is acquired at the gymnasium (in Estonian "gümnaasium"), which is an upper secondary school. The upper secondary school is a general education school, which follows on from basic school and has a nominal study period of three years. Upper secondary schools consisting of years 1 to 12 (i.e. the study period lasts 12 years) have historically prevailed in Estonia. Everyday learning is based on school curricula prepared based on the national curriculum for upper secondary schools.

Upper secondary schools are designed to help students become creative, multi-talented, socially mature and reliable citizens who have discovered a field of endeavor that is best suited to their individual interests and capacities for continuing their future educational path. The study programme at upper secondary school is arranged into mandatory and voluntary courses.

Graduation from upper secondary school requires the student to complete a curriculum consisting of at least 96 individual courses passed at a satisfactory level as a minimum.

Attaining general secondary education entitles students to continue their studies at a higher educational institution or to obtain vocational education.

All subjects including their specific topics can be found in Annex section 9.2.3.

4.4 Germany

After children complete their primary education (at 10 years of age, 12 in Berlin and Brandenburg), there are five options for secondary schooling:

- *Gymnasium* (grammar school) until grade 12 or 13 (with Abitur as exit exam, qualifying for university); and
- *Fachoberschule* admission after grade ten until grade twelve (with Fachhochschulreife (between Abitur and Realschulabschluss) as exit exam) it is also possible to leave after grade thirteen and get either the ″fachgebundene Abitur″

(if you haven't learned a language besides English) or get the "Abitur" (with a second language on European level B1) ;[12]

- *Realschule* until grade ten (with Mittlere Reife (Realschulabschluss) as exit exam);
- *Mittelschule* (the least academic, much like a modernized Volksschule [elementary school]) until grade nine (with Hauptschulabschluss and in some cases Mittlere Reife = Realschulabschuss as exit exam); in some federal states the Hauptschule does not exist and pupils are mainstreamed into a Mittelschule or Regionale Schule instead.
- *Gesamtschule* (comprehensive school) (sorted by the quality and relevance of the exit exam. The comprehensive schools stands apart as it offers each of the mentioned exit exams).

After passing through any of the above schools, pupils can start a career with an apprenticeship in the Berufsschule (vocational school). The Berufsschule is normally attended twice a week during a two, three, or three-and-a-half year apprenticeship; the other days are spent working at a company. This is intended to provide a knowledge of theory and practice. The company is obliged to accept the apprentice on its apprenticeship scheme. After this, the apprentice is registered on a list at the Industrie- und Handelskammer IHK (chamber of industry and commerce). During the apprenticeship, the apprentice is a part-time salaried employee of the company. After passing the Berufsschule and the exit exams of the IHK, a certificate is awarded and the young person is ready for a career up to a low management level. In some areas, the schemes teach certain skills that are a legal requirement (special positions in a bank, legal assistants).

Some special areas provide different paths. After attending any of the above schools and gaining a leaving certificate like Hauptschulabschluss, Mittlere Reife (or Realschulabschuss, from a Realschule) or Abitur from a Gymnasium or a Gesamtschule, school leavers can start a career with an apprenticeship at a Berufsschule (vocational school). Here the student is registered with certain bodies, e.g. associations such as the German Bar Association Deutsche Rechtsanwaltskammer GBA (board of directors). During the apprenticeship, the young person is a part-time salaried employee of the institution, bank, physician or attorney's office. After leaving the Berufsfachschule and passing the exit examinations set by the German Bar Association or other relevant associations, the apprentice receives a certificate and is ready for a career at all levels except in positions which require a specific higher degree, such as a doctorate. In some areas, the apprenticeship scheme teaches skills that are required by law, including certain positions in a bank or those as legal assistants. The 16 states have exclusive responsibility in the field of education and professional education. The federal parliament and the federal government can influence the educational system only by financial aid to the states. There are many different school systems, but in each state, the starting point is always the Grundschule (elementary school) for a period of four years; or six years in the case of Berlin and Brandenburg.

All subjects including their specific topics can be found in Annex section 9.2.4.

4.5 Greece

Secondary schooling is divided into two sections: gymnasio (which is compulsory) and lykeio (which is not compulsory).

Compulsory secondary education

Gymnasio is the first level of secondary education (equivalent to middle or junior high school) and is compulsory for children aged 12 to 15. It lasts three years. The gymnasia school year generally runs from mid-September to mid-May, with classes five days a week. The school week is 34 to 35 hours. Both public and private gymnasia are available.

Pupil assessment is an ongoing process based on daily oral work, written tests, assignments, and projects. Written examinations are held at the end of each term. A leaving certificate allows pupils to continue their studies by enrolling at a lykeio or enter a vocational training programme at the Technical-Vocational Educational Institutes (TEE).

Non-compulsory secondary education

There are two types of schooling available following completion of compulsory education in Greece:

- Unified upper secondary schools (eniaia lykeia/lykeio)
- Technical-vocational Educational Institutes (TEE)

Unified Upper Secondary Schools: The duration of schooling at eniaia lykeia is three years. Lykeio is equivalent to senior high school and, though not compulsory, the majority of students complete it. The lykeio school year generally runs from mid-September to mid-May and the academic week is five days long, with 30-35 hours of instruction.

The first year involves a curriculum of general knowledge, at the end of which students may choose to enter a vocational training programme at the TEE. Conversely, students that opted for a year of TEE instead of lykeio may opt to attend lykeio for one year. After a course of study at the TEE, lykeio, or a combination of both, students will take examinations and, if successfully completed, receive a leaving certificate. The leaving certificate can be used to go on to higher education or vocational training, such as that provided through the Greek Manpower Employment Organisation (OAED).

At the end of lykeio studies, pupils receive their leaving certificate (Apolitirio Eniaiou Lykeiou), and have the following options:

- to seek admission to higher education
- to study at a Vocational Training Institute (IEK)
- to seek employment in the public or private sector

All subjects including their specific topics can be found in Annex section 9.2.5.

4.6 Portugal

In Portugal, a student can follow four routes, in secondary education:

- Scientific humanistic
- Scientific humanistic (recurrent education)
- Scientific technologic
- Other formations

Within each of these courses, there are different specializations. As it follows:

Scientific humanistic

http://www.dge.mec.pt/cursos-cientifico-humanisticos-cch

Within this route, you can find four different courses:

- Science and technology
- Socioeconomic sciences
- Languages and humanities
- Visual arts

Below are listed the different courses available through the “science and technology” path.

Science and technology

http://www.dge.mec.pt/cursos-cientifico-humanisticos-do-ensino-secundario-2

General courses

- Portuguese
- Physical education
- Philosophy
- Foreign language, I, II, III
- Portuguese for deaf students
- Portuguese for students with auditive deficiency
- Portuguese for non-native students

Specific courses

- Mathematics A
- Biology and geology
- Physics and chemistry
- Descriptive geometry
- Biology
- Physics
- Geology
- Chemistry
- Anthropology
- Informatics applications B
- Political science
- Literature classics
- Law
- Economics C
- Philosophy A
- Geography C
- Greek
- Foreign language I, II, III
- Psychology B

Facultative frequency courses

- Religious and moral education

Scientific humanistic (recurrent education)

http://www.dge.mec.pt/cursos-cientifico-humanisticos-ensino-recorrente-cch-er

Within this route, you can find four different courses:

- Science and technology
- Socioeconomic sciences
- Languages and humanities
- Visual arts

Below are listed the different courses available through the “science and technology” path.

Science and technology

General courses

- Portuguese
- Philosophy
- Foreign language, I,II, III
- Portuguese for deaf students
- Portuguese for students with auditive deficiency
- Portuguese for non-native students

Specific courses

- Mathematics A
- Biology and geology
- Physics and chemistry A
- Descriptive geometry A
- Biology
- Physics
- Geology
- Chemistry

Scientific technologic

http://www.dge.mec.pt/cursos-cientifico-tecnologicos-planos-proprios-cct-pp

The programs of the subjects of this path are the same as the Programs of the Scientific-Humanistic Courses.

All subjects including their specific topics can be found in Annex section 9.2.6.

4.7 Finland

The compulsory educational system in Finland consists of a nine-year comprehensive school from 1st to 9th grade, from the ages of 7 to 16 (Finnish peruskoulu, Swedish grundskola, "basic school"), in which attendance is mandatory. (Homeschooling is allowed, but rare). There are no "gifted" programs, and the more advanced children are expected to help those who are slower to catch on.

In most countries, the term "comprehensive school" is used to refer to comprehensive schools attended after primary school, and up to 12th and 13th grade in some countries, but in Finland this English term is confusingly used to include primary school, i.e. it is used to refer to all of the grades 1 to 9 (and not higher grades). One can of course also describe the Finnish grades 1 to 6 in English as being comprehensive schools, but this is unnecessary and confusing because primary schools have always been comprehensive in almost all countries, including Finland. In addition, it is best to not try to translate the Finnish term peruskoulu with a single term in English. In order to avoid confusion in English, it is best to describe the Finnish compulsory education system as consisting of 6-year primary schools, called alakoulu or ala-aste in Finnish, followed by comprehensive 3-year middle schools, called yläkoulu or yläaste in Finnish. Although this division of the peruskoulu into two parts was officially discontinued, it is still very much alive — the distinction is made in everyday speech, the teachers' training and classification and teaching, and even in most school buildings. In addition, the use of two different terms for grades 1-6 and 7-9 is easier to understand for people from most other countries, most of which do not have a single term for primary and middle schools. On the contrary, middle schools and high schools are usually included in the term secondary education in English.

Upper secondary education begins at 16 or 17 and lasts three to four years (roughly corresponding to the last two years of American high school plus what in the USA would be a two-year Community or Junior College). It is not compulsory. Finnish upper secondary students may choose whether to undergo occupational training to develop vocational competence and/or to prepare them for a polytechnic institute or to enter an academic upper school focusing on preparation for university studies and post-graduate professional degrees in fields such as law, medicine, science, education, and the humanities. Admissions to academic upper schools are based on GPA, and in some cases academic tests and interviews. For example, during the year 2007, 51% of the age group were enrolled in the academic upper school.

All subjects including their specific topics can be found in Annex section 9.2.8.

4.8 France

The collège is the first level of secondary education[16] in the French educational system. A pupil attending college is called collégien (boy) or collégienne (girl). Men and women teachers at the collège- and lycée-level are called professeur (no official feminine professional form exists in France although the feminine form "professeure" has appeared and seems to be gaining some ground in usage). The City of Paris refers to a collège in English as a "high school."[1]

The lycée is the second, and last, stage of secondary education in the French educational system.

Until 1959, the term lycée designated a secondary school with a full curriculum (7 years, the present college + lycée) directly under the supervision of the State, then from 1959 to 1963 any secondary school with a full curriculum. Older lycées still include a collègesection, so a pupil attending a lycée may actually be a collégien.

At the end of the final year of schooling, most students take the baccalauréat diploma.

Lycées are divided into (i) the lycée général, leading to two or more years of post–baccalauréat studies, (ii) the lycée technologique, leading to short-term studies, and (iii) the

[16] http://timssandpirls.bc.edu/timss2015/encyclopedia/countries/france/

lycée professionnel, a vocational qualification leading directly to a particular career. General and technological education courses are provided in "standard" lycées, while vocational courses are provided in separate professional lycées.

In practice, competent pupils at a vocational lycée professionnel can also apply to take short-term, post–baccalauréat studies leading to the Brevet de technicien supérieur (BTS), a vocational qualification. This option is also available to pupils at a lycée général.

Lycée général and lycée technologique

In France, the lycée général is the usual stepping-stone to university degrees. During their year in Seconde students make their final choice of série (course) for the final two years. During the seconde, students mostly take the same courses, despite having different academic skills and interests, so it is usually thought to be an easier year than either the première or the terminale.

General streams
After the seconde, most French students choose a general course. In all courses, some subjects occupy more hours in the student's timetable. The baccalauréat examination is different for all three séries, and subjects are weighted according to the course taken.

All subjects including their specific topics can be found in Annex section 9.2.8.

4.9 Spain

After primary school in Spain students must continue on to Compulsory Secondary Education (ESO) which generally lasts from age 12-16. **Spanish secondary education** is divided into two cycles lasting two years each.

Once a Spanish student graduates from ESO, students have three different choices:

1. High school known as the Spanish Baccalaureate (*Bachillerato*)
2. Vocational/Professional training (Electrician, hairdresser, etc)
3. Enter the work force

The **Spanish high school** Baccalaureate is non-compulsory free education that consists of one cycle in two academic years for students age 16-18. The Spanish Baccalaureate consists of a series of required common classes, elective classes and specialization classes known as "*modalidades*", or concentration in a certain discipline. A student must specialize in one of the offered disciplines and if the students plan to continue on to university, certain concentrations may be required in order to be admitted into certain university programs.

Required classes of the Spanish Baccalaureate include 2 years of both Castilian language and literature (or the co-official language) and foreign language, and 1 year of philosophy and civic responsibility, physical education, contemporary science, history of philosophy and the history of Spain.

Elective courses may include: a second foreign language, information technology, dance, art, theater, music, or other classes depending on the school.

The specialization part of the Spanish high school Baccalaureate requires a student choose one of 4 concentrations for which they will be required to take 3-4 classes a year. Each concentration has obligatory classes and other classes from which to choose from.

1. **Arts**: The arts discipline is divided into two concentrations: art, image and design; or performing arts, music and dance.

2. **Science and Technology**: math, biology, physics, chemistry, geology, technical drawing, etc.
3. **Humanities and Social Sciences**: applied math, economics, Latin, Greek, contemporary history, geography, art history, business economics, etc.

Students who successfully complete the requirements of the Spanish high school Baccalaureate will receive a diploma. They may then opt for vocational training, a university education, or in some cases both. In order to continue on to the university they must take an entrance exam (*Prueba de Acceso a la Universidad - PAU*). The test results together with the student's academic record and grades will determine not only access to the university but also which degrees the student can pursue.

4.10 The Netherlands

After attending elementary education, children in the Netherlands (by that time usually 12 years old) go directly to high school (voortgezet onderwijs; literally "continued education"). Informed by the advice of the elementary school and the results of the Cito test, a choice is made for either voorbereidend middelbaar beroepsonderwijs (VMBO), hoger algemeen voortgezet onderwijs (HAVO) or voorbereidend wetenschappelijk onderwijs (VWO) by the pupil and their parents. When it is not clear which type of secondary education best suits a pupil, or if the parents insist, their child can handle a higher level of education than what was recommended to them, there is an orientation year for both VMBO/HAVO and HAVO/VWO to determine this. At some schools, it is not even possible to do HAVO the 1st year, so you have to do a combination. After one or two years, the pupil will continue in the normal curriculum of either level. A high school can offer one or more levels of education, at one or multiple locations. A focus on (financial) efficiency has led to more centralization, with large schools that offer education on all or most educational levels.

Since the Dutch educational system does not have middle schools or junior high schools, the first year of all levels in Dutch high schools is referred to as the *brugklas* (literally "bridge class"), as it connects the elementary school system to the secondary education system. During this year, pupils will gradually learn to cope with the differences between school systems, such as dealing with increased personal responsibility. Sometimes people also call the second year *brugklas*. Students are often referred to as *bruggers*.

It is possible for pupils who have attained the VMBO diploma to attend the final two years of HAVO level education and sit the HAVO exam, and for pupils with a HAVO diploma to attend the final two years of VWO level education and sit the VWO exam. The underlying rationale is that this grants pupils access to a more advanced level of higher education. This system acts as a safety net to diminish the negative effects of a child's immaturity or lack of self-knowledge. For example, when a bright pupil was sent to VMBO because she/he was unmotivated but later discovered its potential or has acquired the desire to achieve better, the pupil can still attain a higher level by moving on to HAVO. Most schools do require a particular grade average to ensure the pupil is capable of handling the increased study load and higher difficulty level.

Aside from moving up, there is also a system in place where pupils can be demoted to a lower level of education. When for example a pupil has entered secondary education at a level they cannot cope with, or when they lack the interest to spend effort on their education resulting in poor grades, they can be sent from VWO to HAVO, from HAVO to VMBO, and from any level of VMBO to a lower level of VMBO.

All subjects including their specific topics can be found in Annex section 9.2.10.

4.11 UK

In the UK, secondary education is mainly covered by KS3, KS4 and KS5. **Key Stage 3** (commonly abbreviated as **KS3**) is the legal term for the three years of schooling in maintained schools in England and Wales normally known as Year 7, Year 8 and Year 9, when pupils are aged between 11 and 14. In Northern Ireland the term also refers to the first three years of secondary education, although these are known as Year 8, Year 9 and Year 10.

The term is used to define the group of pupils who must follow the relevant programmes of study from the National Curriculum[17]. All pupils in this Key Stage must follow a programme of education in at least 15 areas

- English
- Mathematics
- Science
- Computing
- Design and Technology
- History
- Geography
- Modern Foreign Language
- Art and Design
- Music
- Physical Education
- Citizenship
- Sex Education
- Career education
- Welsh (in Wales only)

At the end of this stage, pupils aged 14 — in Year 9 — are assessed as part of the national programme of National Curriculum assessment. Until 2008 this involved a series of externally marked tests.[1] However, from 2009, this will be based on on-going teacher assessment, with results for each school being published in performance tables.

Key Stage 4 is the legal term for the two years of school education, which incorporate GCSEs, and other examinations, in maintained schools in England normally known as Year 10 and Year 11, when pupils are aged between 14 and 16.

The term is used to define the group of pupils who must follow the relevant programmes of study from the National Curriculum. All pupils in this Key Stage must follow a programme of education in the following areas:

- English
- Mathematics
- Science
- Information and Communication Technology (England only)
- Physical Education

[17] https://en.wikipedia.org/wiki/National_Curriculum_(England,_Wales_and_Northern_Ireland)

- Citizenship
- Sex Education
- Careers Education
- Religious Education
- Work-related learning
- Welsh (Wales only)

In addition, there is a statutory duty on schools to provide an optional programme of education for pupils in this Key Stage in each of the following areas:

- The Arts
- Design and Technology
- The Humanities
- Modern Foreign Languages

At the end of this stage, pupils aged 16 - in Year 11 - are normally entered for a range of external examinations. Most frequently, these are GCSE (General Certificate of Secondary Education) examinations, although a range of other qualifications is growing in popularity, including NVQ National Vocational Qualifications. These examinations are set by one of the examination boards. Results of examinations at this age are published as part of the Department for Children, Schools and Families' Performance Tables.

Key Stage 5 is a label used to describe the two years of education for students aged 16-18, or at sixth form, in England, Wales and Northern Ireland, aligning with previous Key Stages as labelled for the National Curriculum.

Halfway through Key Stage 5, students sit the GCE Advanced Subsidiary Levels examination and at the end of Key Stage 5, they sit the A2 Level examinations. Both AS and A2 level combined form the GCE Advanced Level qualification.

Key Stage 5 is also the stage of education where students go through more intense and challenging courses in very specific subjects like mathematics and physics. This stage is the last stage of secondary education for members of sixth form. When A levels are achieved the students will be able to apply to university.

All subjects including their specific topics can be found in Annex section 9.2.11.

5. Big ideas of Science

The purpose of this chapter is to present the reasoning and the methodology under which the Go-Lab ecosystem will be classified and presented under the theoretical framework of the "Big Ideas of Science". Through this process, we aim the Next-Lab project to follow the current pedagogical tendency, which imposes the interdisciplinary teaching and the integrated approach for STEM subjects to students' curricula. In particular, the current trend in education is the transformation from *subject-based curricula* to interdisciplinary *project-based curricula*. Furthermore, through the tool of the Big Ideas of Science we expect to penetrate the strictly time-bounded student curricula and to form the maximum possible space for Inquiry Based Learning (IBL) in the classroom.

This chapter is organized as follows: In Section 5.1 we explain in detail the benefits and the benefit of implying the Big Ideas of Science in Next-Lab. In section 5.2 we briefly present the set of the Big Ideas that has been chosen for the Go-Lab Ecosystem and the current classification of the online labs and ILSs. Finally, in section 5.3.1 we discuss the implementation of the Big Ideas through the construction of a two-dimensional sequence of ILSs. The first dimension refers to the coverage of all scientific topics of students' curricula, while the second one to the gradual evolution of the ILSs from one age range to another.

5.1 The Big Ideas of Science in the Go-Lab Ecosystem

The Next-Lab project aims to motivate young students for further engagements to scientific disciplines following the pedagogical approach of the inquiry learning. Considering the technological advantages in the guided inquiry learning (de Jong 2006; Waldroep et al. 2013), Next-Lab attempts to introduce the online labs in the classroom, and with the support of the ILSs, to structure students' inquiry process through an inquiry cycle. Finally, the involvement of active and pre-service teacher in the formation and the application of an ILS guarantees the smooth embedding of the project in the national educational curricula and the characteristics of each class (de Jong et al. 2014). Nevertheless, the aforementioned advantages offered by the Next-Lab project could possibly be tempered if we do not take into account and address two main issues that are revealed by the current educational framework:

1. The first one is the tendency of students to find science disciplines, as presented in school curricula, unclear and meaningless and thus, not interesting and irrelevant to their lives. The underlying reason for this phenomenon is the anachronistic approach of science education applied currently in schools. According to it, science has been designed to be taught only to students, who will follow a scientific career (Harlen 2010), while any strategic bridging between the topics of different scientific disciplines is absent. As a result, students are daily "bombarded" with fragmented and abstractive terms, definitions and formulas that lack any obvious link to the surrounding world or student's life.
2. The second factor that we should consider is the time limitations imposed by current educational systems. One scientific topic (e.g. photosynthesis) should be delivered in one or maximum two teaching hours of ~45 min. Within this period, applying Inquiring Based Learning, as described in the framework of Next-Lab, is not easily feasible and laborious, both for teachers and for students.

The theoretical tool that we are willing to impose in the Next-Lab project in order to cope with and overcome the aforementioned issues is the so-called "Big Ideas of Science" (Harlen 2010). The Big Ideas of Science is a set of crosscutting, fundamental scientific

concepts. Each Big Idea hosts concepts of different science disciplines and interconnects different phenomena, which seemingly appear irrelevant to each other. The whole set of Big Ideas forms an underlying, cross-curricular net on which all the scientific concepts and phenomena included in school curricula can be constructed and explained respectively. For instance, the phenomena of photosynthesis, a nuclear explosion and the motion of a comet around the sun can be grouped under the umbrella of a Big Idea named “conservation and transformation of energy”.

Nevertheless, the phenomenon of photosynthesis can also be linked to topics such as living beings’ nutrition and the composition of earth’s atmosphere. Similarly, the nuclear explosion could be linked to the topics like atomic structure and the strong nuclear force, while the orbit of a comet to the structure and formation of the Solar System, the force of gravity, the conic sections, etc. Hence, from the already known subjects “nuclear explosion” and “orbits of planets” the students can be smoothly introduced to another Big Idea: “The fundamental forces”, under which they will learn other scientific topics relevant to this subject. In this way, the spectrum of science disciplines is presented to students as a meaningful and coherent canvas of interconnected and complementary images/concepts, which all together synthesize the world around us.

Through the adaptation of the Big Ideas of Science to the Go-Lab ecosystem, the labs and the ILSs can be classified accordingly. This classification helps teachers to present their own ILSs in a meaningful and smooth storyline, gaining in this way the educational benefit described above (see also Benjamin 2006).

Furthermore, by creating and publishing ILSs in Go-Lab through the aspect of the Big Ideas, we are able to mitigate the time limitation imposed by current educational systems, allowing more space for inquiring based learning. Under the mainstream subject-based educational approach, in order to impose IBL in the classroom and cover though this approach the science curricula, a significant number of topics of each science discipline should be presented accompanied by an ILS. This one-to-one correlation of ILSs to scientific subjects of each discipline, results to large number to ILSs whose application is quite challenging in the given period of each subject.

On the other hand, by reducing the content or amounts of ILSs to a more pragmatic and realistic classroom approach, we risk ending up with a limited number of ILS that only cover the curriculum partially. Nevertheless, creating and presenting ILSs in the framework of the Big Ideas of Science a sequence of *interdisciplinary* ILSs can be formed, designed in a way to achieve the optimum traversal through the science curriculum. Using the Big Ideas we can identify the common ground between different disciplines and in this way design ILSs that are able to cover multiple topics at the same time. Subsequently, a smooth transition from one ILS to another can be achieved through the overlapping thematic areas of the Big Ideas, forming in this way a consistent, meaningful storyline. Figure 2 below presents an abstractive example which illustrates the difference between the two approaches. In this example, a hypothetical weekly student program is presented. Under the subject-based approach (upper table), eight ILSs have been used to cover most of the topics of the science classes. On the other hand, under the Big Ideas approach (bottom) three ILSs have been used achieving a similar coverage of the science curriculum as they satisfy at the same time topics of different disciplines. The arrows in this table represent the transition of one ILS to the other through the cross-cutting set of Big Ideas. The methodology under which the Big Ideas will be applied and as well as an example of a sequence, if ILSs formed under this approach will be presented in section 5.3.1 .

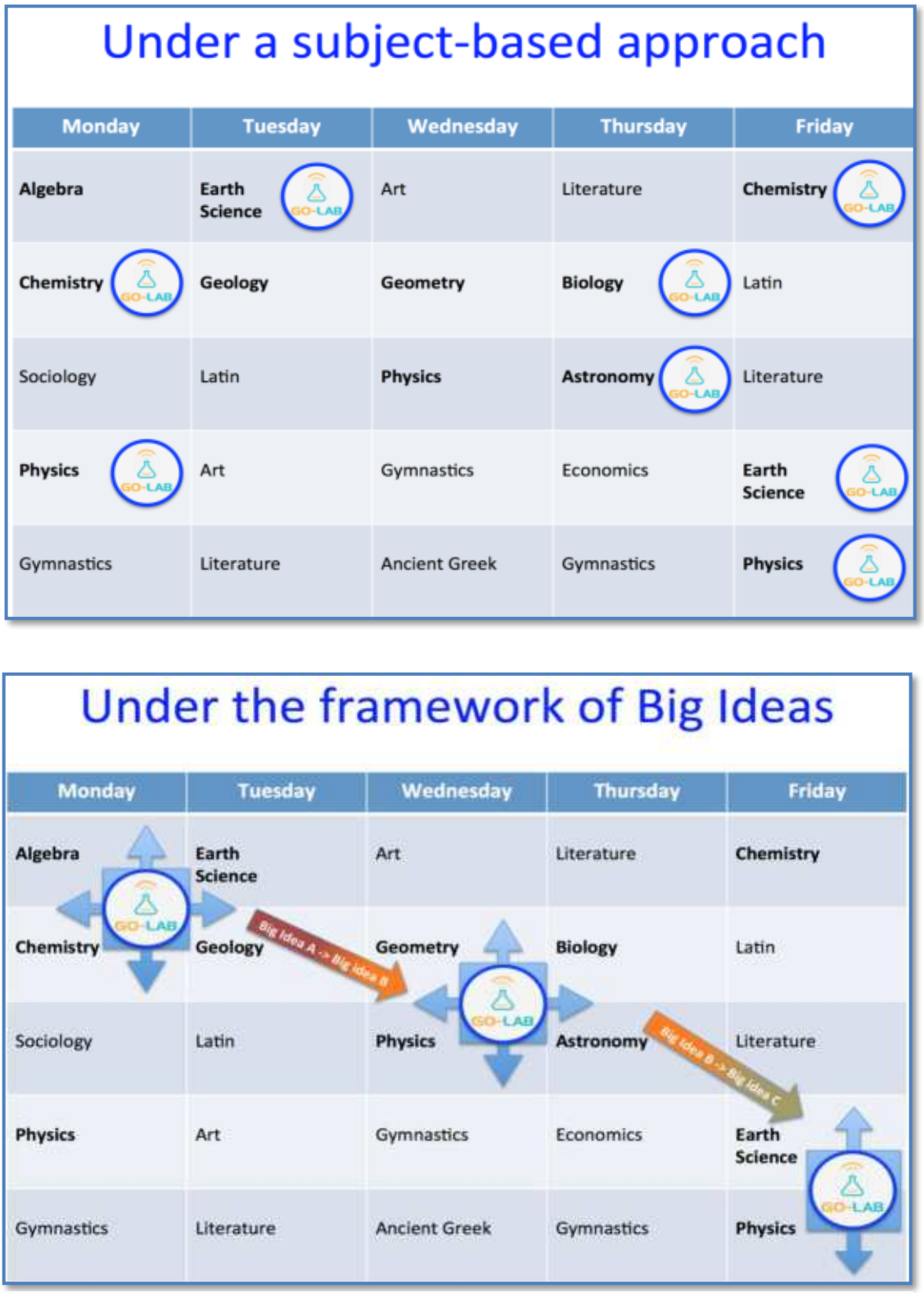
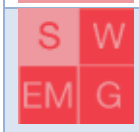
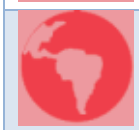


Figure 2: The schematic illustration of the implementation of the Go-Lab ILS in the school curriculum under a classical aspect (up) and under the framework of Big Ideas (down). The symbols of Go-Lab logo correspond to an ILS application in the classroom

5.2 The Big Ideas of Science in Go-Lab

In the preceding Go-Lab project (see deliverable G2.2 Section 2.3) partners decided to construct their own set of Big Ideas of Science as the existing ones were revealing some missing parts of important aspects or some other were disclosing substantial overlapping. Thus, the existing set of Big Ideas (Harlen 2010; Denver Public Scholls 2009; Talanquer 2013; Wood 2009; Ross and Duggan-Haas 2010) have been combined, they had faced several adaptations and eventually a new set of eight big ideas was formed, which is tabulated in Table 5.

Table 5: The Big Ideas of Science in Go-Lab

Symbol	Title	Description
	Energy Transformation	Energy cannot be created or destroyed. It can only transform from one form to another. The transformation of energy can lead to a change of state or motion.
	Evolution And Biodiversity	Evolution is the basis for both the unity of life and the biodiversity of organisms. Organisms pass on genetic information from one generation to another.
	Fundamental Forces	There are four fundamental interactions/forces in nature. Gravitation, electromagnetism, strong nuclear, and weak nuclear. All phenomena are due to the presence of one or more of these interactions. Forces act on objects and can act at a distance through a respective physical field causing a change in motion or deform the object
	Microcosm	In very small scales, our world is subjected to the laws of quantum mechanics. All matter and radiation exhibit both wave and particle properties. We cannot simultaneously know the position and the momentum of a particle.
	Organisms And Life Forms	Cells are the fundamental unit of life. They require a supply of energy and materials. All life forms on our planet are based on a common key component.
	Our Universe	Earth is very small part of the universe. The universe is comprised of billions of galaxies, each of which contains billions of stars (suns) and other celestial objects. Earth is a very small part of a solar system with our sun in its centre that in turn is a very small part of the universe.
	Planet Earth	Earth is a system of systems, which influences and is influenced by life on the planet. The processes occurring within this system influence the evolution of our planet, shapes its climate and surface. The solar system also influences Earth and life on the planet.
	Structure Of Matter	All matter in the Universe is made of very small particles. They are in constant motion and the bonds between them are formed by interactions between them. Elementary particles as we know them so far from atoms and atoms form molecules. There is a finite number of types of atoms in the universe, which are the elements of the periodic table.

This set of Big Ideas with the relevant description was presented in the Golabz website (see Figure 3, left). Additionally, the labs and ILSs of the Go-Lab Ecosystem have been classified under the aspect of the Big Ideas. In the home page of Golabz, the list of the Big Ideas is presented. By clicking on one of them, the viewer can see the corresponding labs and ILSs (see Figure 3, upper-right). Finally, in the characterization of each lab or ILS among others is the category “Big Ideas of Science”. There it is presented the Big Ideas that are connected to this specific lab (see Figure 3, bottom-right). In this way, the users of Golabz can easily group the labs/ILSs according to the Big Idea of Science and through it to help them to construct a sequence of labs/ILSs through the proper intersections between the Big Ideas.

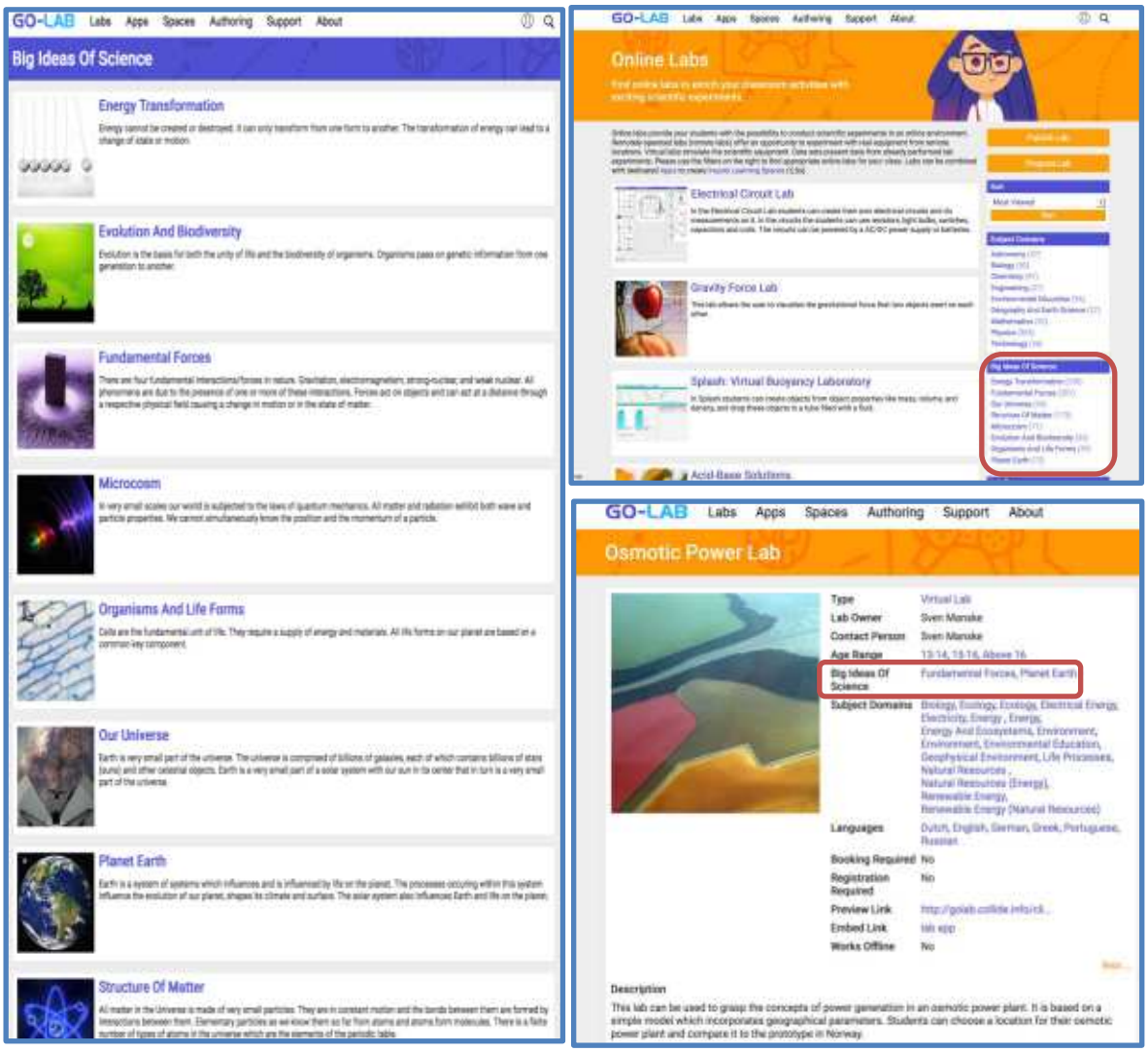


Figure 3: Left: The page of the Go-Lab website in which the Big Ideas of Science are presented and briefly described. Upper-right: The categorization of the labs and ILSs under the criterion of the Big Idea of Science. Bottom-Right: An example of a lab which description includes the relevant Big Ideas of Science

5.3 Implementation of Big Ideas on Next-Lab

The use of Go-Lab ILSs through the prism of the Big Ideas of science is expected to face some challenges and will have to deal with the difficulties that accompany any innovative educational methodology. This is because apart from the theoretical framework needed in order to establish an educational theory, it is also required the essential (technical) “know-

how" for its application. The solution to be offered will have to consist of dedicated training (e.g. in form of summer schools) and by providing a series of example ILS that form together a proposed way to teach the Big Ideas.

There are three new elements in the Next-Lab project, in comparison to Go-Lab project, which can act beneficially to the implementation of the Big Ideas methodology in the classroom. These are the following:

- Next-Lab has extended its target group and it has been introduced to the **pre-service secondary teacher training programs** throughout Europe. Thus, the Big Ideas methodology can be introduced already early in the teachers' education, and be introduced to ongoing teachers that usually are more open to include innovative methodologies in their pedagogic toolbox.
- The additional focus of the Next-Lab project in **primary education**. This educational level is ideal for the application of the Big Ideas as in most countries the science disciplines are taught by the same teacher. Hence, in primary education the application of Big Ideas does not demand the teacher's collaboration, which in some cases can act discouragingly, as the whole design of the ILSs can be done by one teacher who has the absolute overview of the science topics taught in each class.
- The design of a **set of exemplary, high quality ILSs**, 40 for primary and 20 for secondary education, co-created between teachers, scientists, and graphical design experts (Task 2.5). These ILSs, that will function as an inspiration for the teachers, will be standing out on the one hand, for their educational, scientific and design thoroughness and on the other hand, for their meaningful and continuous sequence. This sequence will be structured in order to form a network of crosscutting, interdisciplinary storylines that intersect the science curriculum achieving its maximum coverage. To achieve this, the curriculum analysis of this deliverable for both primary and secondary schools has been undertaken and the common science topics have been identified that appear in all curricula (see Section 6). Subsequently, some partners in task 2.5 are planning to design exemplary ILSs aiming to achieve the maximum coverage of this common ground of the science curricula. Finally, these ILSs will not be sporadically distributed in this common ground but instead, through the Big Ideas methodology, they will be strongly linked to each other forming in this way a network of meaningful sequences.

5.3.1 An example implementation of Big Ideas on Next-Lab

In this section, we attempt to illustrate the main methodology that will be followed for the construction of a sequence of ILSs under the aspect of the Big Ideas of Science and to present the advantages of this method over the construction of subject-based ILSs.

In section 6.1 the set of curriculum topics that appear to be common in science education in Europe is tabulated. For the example in this section, we have chosen seven science topics of four different disciplines of primary school curricula, which we are planning to introduce to the classroom through ILSs. The chosen topics, their corresponding disciplines, and some relevant labs from Go-Lab are presented in Table 6**.**

Under the subject-based approach, the teacher has to introduce the aforementioned seven topics in the classroom through a number of ILSs, which include some of the relevant labs. For instance, in the course of biology the teacher introduces the topic plans nutrition through an ILS that includes the lab "The importance of light in photosynthesis". Subsequently, in the course of environmental science, in the topic "Relationship between environment and

life" the students follow the lab "Sunlight, infrared CO_2 and the ground", while at the course of physics the topic of energy conservation is introduced by imposing the labs "Energy loss" and "Basketball ball" etc.

Table 6: The 6 topics from primary school European curricula used in our example, their corresponding science disciplines, and some examples of relevant Labs from the Go-Lab ecosystem

Discipline	Topic	Examples of Relevant Labs
Biology	Plans nutrition/ photosynthesis	• Photolab • The importance of light in photosynthesis
Environment	Environmental threat	• Carbon Stabilization Wedges • Sunlight, infrared CO_2 and the ground • Air pollution • CFCs in the atmosphere
	Alternative sources of energy	• Solar Lab • Windmill lab • Sunlight, infrared CO_2 and the ground
	Relationship between environment and life	• Island Biogeography • Sunlight, infrared CO_2 and the ground • Mutations
Physics	Phenomena of Light & Temperature	• The colours of light • Colour vision • Spectrum • Molecules and Light • Bending light • Lens
	Energy Conservation and transformation	• Energy loss • Single string • Pendulum Lab • Basketball ball • Solar Lab • Windmill lab • Lego windmill lab
Astronomy	The motions of Earth, day and night and seasons	• Sun4all • Motions Of The Sun Simulator • Seasons And Ecliptic Simulator • SunCalc

Nevertheless, these seven topics can be presented under a sequence of ILSs able to connect these topics through a solid storyline. Such a story line is presented in Table 7. Each chapter of the storyline is linked to one or more Big Ideas. The Big Ideas function as the navigation compass where the creator/presenter of the ILSs can use to identify the bridging spots from one chapter to the other. In this way, the topics of each discipline are presented like pieces of a puzzle, which all together form meaning full image. For instance, in our example the student realizes the connection of the light frequency on the interaction of light and matter and by that the importance of Solar radiation properties and Earth's atmosphere composition on earth's climate and consequently to the maintenance of life.

Table 7: An example of a storyline formation based on the Big Ideas of Science, which attempts to cover several topics of primary school curriculum of science

ILS name	Description	Relevant lab	Big Ideas
Colors of light	Students are introduced to the nature of light. They learn that the beautiful colors around them are just the different "dresses" of the same protagonist: the light.	• Color vision • The colors of light	• Structure Of Matter • Microcosm
Spectrum & energy of light	Student broad their vision about the nature of light realizing that visual light is just a tenuous window of the whole electromagnetic spectrum. They are also introduced to the wave nature of light and realize that light carries energy, which is determined by its frequency.	• Spectrum	• Microcosm
Light energy transformation	The energy carried by light can be transformed to other forms of energies. In this session students learn about the increase of the kinetic energy of the molecules that interact with light, increasing with this way the temperature of the medium they belong to, and the light energy transformation to electric energy a process that solar panels function is based.	• Molecules and Light • Solar Lab	• Energy Transformation • Structure Of Matter • Microcosm
Sunlight: the main source of energy	The main source of earth's energy is our star: the Sun. This energy is transferred from Sun to Earth through the Solar radiation. Due the shape and the position of Earth the solar radiation covers the one hemisphere of Earth. The rotation of Earth results to the 24^{th} succession of day to night. The motion of Earth around the Sun is related to seasons are it determines the angle of incidence of Solar radiation to Earth's surface.	• Motions Of The Sun Simulator • Seasons And Ecliptic Simulator	• Our Universe
Vital balance: CO_2, Ozone	From the moment that solar radiation will reach Earth the amount the energy that It carries will be absorbed by earth is determined by Earth's atmosphere. Two main parameters are discussed. The ozone layer, which absorbs the harmful UV radiation and the amount CO2 in the atmosphere responsible for the Green House effect. The two parameters are responsible for Earth's climate and consequently for life existence in the planet.	• Sunlight, infrared CO_2 and the ground • Planetary Climates: A Delicate Balance	• Our Universe • Structure of matter • Planet Earth

Pollution: CO_2, CFC	However, both these parameters that balance the Earth climate are affected by human activity, which increases dramatically the amount of CO_2 in the atmosphere and at the same time, destroys the Ozone layer. If we will not take immediate measures to change the situation the human activity will have fatal consequences on life on Earth.	• Air pollution • CFCs in the atmosphere	• Planet Earth

In the previous example, a story was formed having as the main protagonist the light and its nature. Other stories with other protagonists can be formed which will cover different topics and disciplines. Nevertheless, the creation of a number of storylines should not be random but in the contrary, should aim to form an *intersecting network* of storylines. An example is illustrated in Figure 4, where the aforementioned storyline is crossed with the other one, which debates the issue of energy conservation and the energy resources of human needs. These two storylines are crossing each other in two chapter: the "Pollution CO_2, CFC" and the "Light Energy Transformation". Such a structure reveals two important advantages. On the one hand, it makes clear to the students the unity of science and on the other hand, through this overlapping is time efficient, as less ILSs are demanded to cover the curriculum.

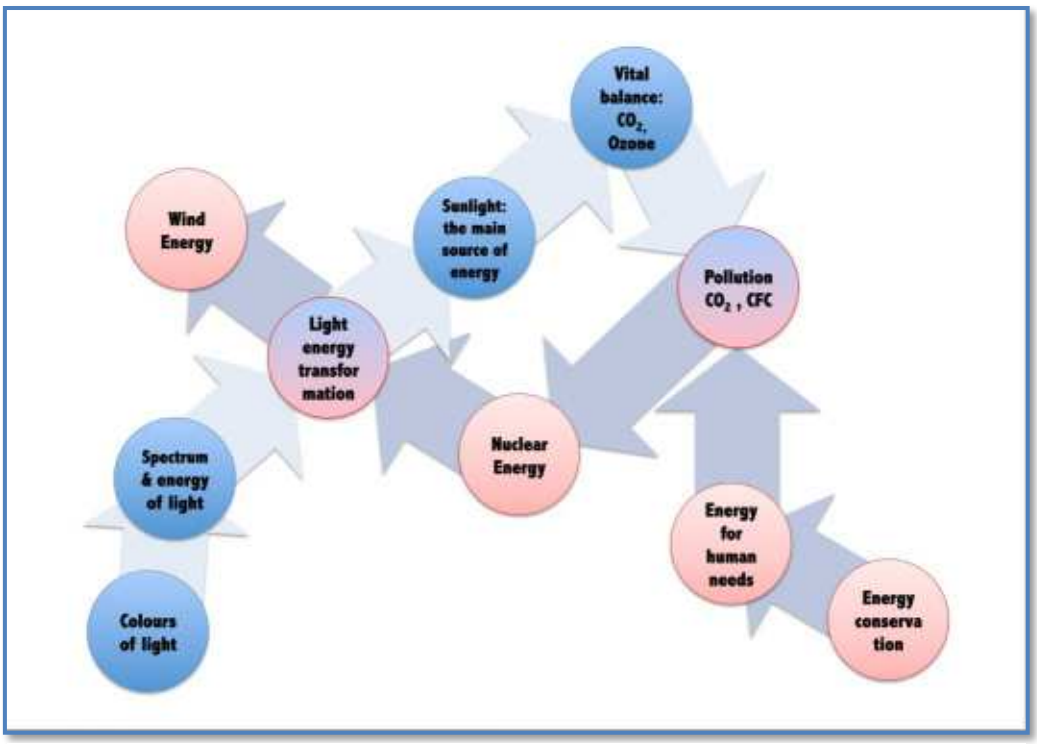


Figure 4: The two crosscutting storylines covering the studied topics of the primary school curriculum (see text for details)

A similar process should be followed at the secondary school education. In Figure 5 another example of two crosscutting sequences of ILSs is depicted for the secondary school education. These two sequences which also have as a protagonist the nature of light have common starting point: "The black body radiation" and ending point: "The Infrared spectra Window" and the "Climate change". However, they follow two different paths. The one path

focuses on Astronomy & Quantum physics and the other on Earth and Environment. The optimum for a school is to follow both paths. However, such a structure provides to schools the flexibility to follow one of them given either the time limitations, or the priority topics of the curriculum.

The networks of ILS created for the primary and secondary education should also not be formed independently from each other. In the contrary, creation of the ILSs on a school level should be based on the knowledge that students have gained from the previous classes. In this way, a smooth evolution and upgrade of science topics can be achieved where students can recall their previous knowledge at the start to deal with a new topic. In Figure 6 such an evolution of ILSs from one educational level to a higher one is depicted, using the two sequences of ILSs presented in this section. The orange arrows indicate this transition of similar topics from primary school education to the secondary. For instance, the topic "Spectrum and energy of light" can be used as the introduction to the secondary school level topic "Blackbody Radiation the Sun" etc. As a result a two dimensional map of ILSs can be formed where the first dimension concern the coverage of the science curriculum in each age range and the other on the smooth evolution to the next school level.

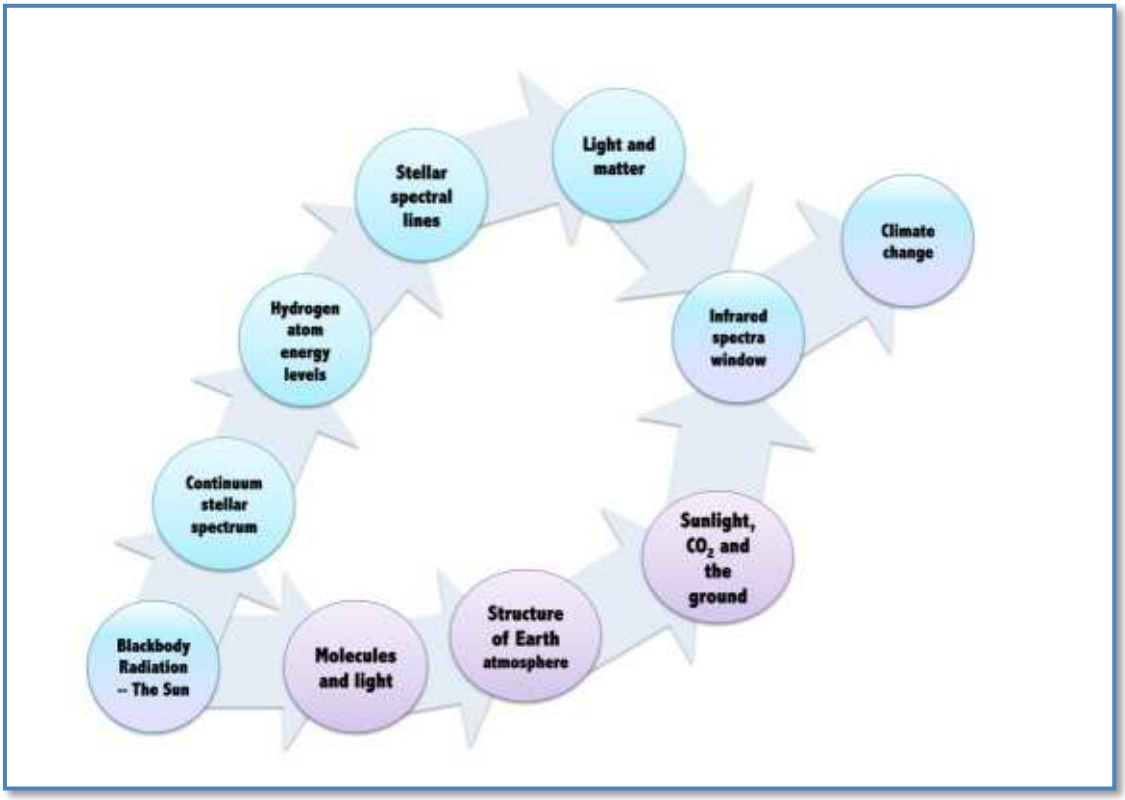


Figure 5: The same as Figure 4 but for the secondary school education

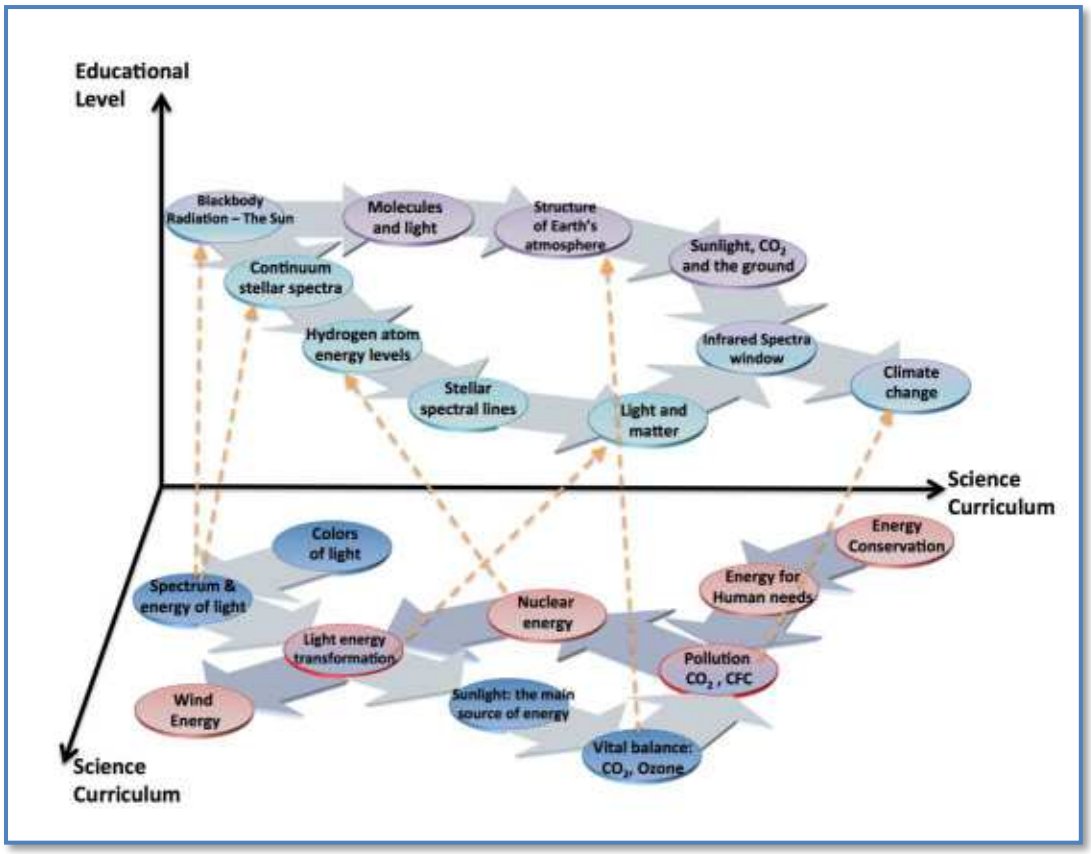


Figure 6: The evolution of the sequences of ILSs from one school level to another. The orange arrows indicate the common topics of the two levels

6. Curriculum analysis results

6.1 Curriculum analysis primary education results

6.1.1 Science

The following results are the output of the primary curriculum analysis of all 11 countries for the subjects of science:

Age	Subject	Pupils Learn	Corresponding Big Idea(s) of Science
5 to 6	Materials, processes and states of matter	To distinguish between an object and the material from which it is made	Structure of Matter
		To identify and name a variety of materials, including wood, plastic, glass, metal, water, and rock.	Structure of Matter
		How to identify solid, liquid and gas objects.	Structure of Matter
	Space and time	-	-
	Plans and nature	To identify and name a variety of common plants.	Organisms and Life Forms Evolution and Biodiversity
		To identify basic concepts related to forests (i.e. air, soil, branches, stem, roots, leaves, flora, fauna etc.).	Organism and Life Forms Planet Earth
	Animas and humans	To identify and name a variety of common animals including fish, amphibians, reptiles, birds and mammals.	Organisms and Life Forms Evolution and Biodiversity
		To recognize and identify physical characteristics of the body, sexual identity, parts of the body and to make comparisons.	Organisms and Life Forms Evolution and Biodiversity
		To identify, name, draw and label the basic parts of the human body and say which part of the body is associated with each sense.	Organisms and Life Forms
	Other Topics	-	
6 to 7	Materials, processes and states of matter	To study and experiment with materials (e.g., sugar, salt, wood, and clay) and classify them according to their characteristics	Structure of Matter
		To identify and compare the suitability of materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses.	Structure of Matter

		To distinguish between solids and liquids and perceive changes in states of matter.	Structure of Matter Energy Conservation
		To do simple experiments with water: capacity and volume, physical properties, recognition of floating materials, etc.	Structure of Matter
		About basic types of energy, energy saving and about alternative source of energy.	Energy Transformation
		About energy and the human body, everyday habits and energy consumption at school and home.	Energy Transformation Planet Earth
	Space and Time	To identify the alternation of day and night, weeks, months, and seasons. To use tools for tracking and measuring time.	Planet Earth Our Universe
		To discover and memorize particular points of reference in time, the relation between the sun's position in the sky and the rotation from day to night.	Our Universe
		To observe changes across the four seasons.	Our Universe Planet Earth
	Plants and nature	To identify different habitats.	Evolution and Biodiversity Organisms and Life Forms
		To identify and describe the basic structure of a variety of common flowering plants, including trees.	Evolution and Biodiversity Organisms and Life Forms
	Animals and humans	To Identify and name a variety of common animals that are carnivores, herbivores and omnivores.	Evolution and Biodiversity Organisms and Life Forms
		To describe and compare the structure of common animals (fish, amphibians, reptiles, birds and mammals).	Evolution and Biodiversity Organisms and Life Forms
		Find out about and describe the basic needs of animals, including humans, for survival (water, food and air).	Organisms and Life Forms Energy Conservation Planet Earth
		To identify the characteristics of living things (i.e., birth, growth, and reproduction), nutrition and animal diets.	Evolution and Biodiversity Energy Conservation

		To explore and compare the differences between things that are living, dead, and things that have never been alive.	Evolution and Biodiversity Energy Conservation
	Other topics	How time is measured and to get familiar with vocabulary and expressions around it.	Our Universe
7-8	Materials, processes and states of matter	To do simple experiments and observations with materials, studying their properties (e.g., flexibility, resistance, solubility, and transparency).	Structure of Matter
		To compare and group together different kinds of rocks and to describe how fossils are formed.	Structure of Matter Planet Earth
		To recognise that soils are made from rocks and organic matter.	Structure of Matter Planet Earth
		To recognise light and darkness, shadows and its relation to light.	Microcosm Energy Transformation
		To do simple experiments with air (e.g., balloons and syringes) and recognize properties of air (e.g., weight and temperature) and air's effects on different objects.	Structure of Matter
	Space and time	How to relate different weather conditions with the different seasons and a place's geographical position.	Our Universe Planet Earth
	Plants and nature	About different levels and characteristics of biodiversity and factors threatening biodiversity.	Evolution and Biodiversity Planet Earth
		About rare and endangered plants.	Evolution and Biodiversity Planet Earth
		To identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves and flowers.	Evolution and Biodiversity Organisms and Life Forms
		To explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant.	Organisms and Life Forms Energy Transformation
		To explore the part that flowers play in the life cycle of flowering plants (pollination, seed formation and seed dispersal).	Planet Earth Evolution and Biodiversity Organisms and Life Forms
	Animals and humans	About stages and conditions of development of a living thing, including breeding patterns	Organisms and Life Forms

		and factors affecting the development of animals.	Planet Earth Energy Transformation
		About rare and endangered animals.	Evolution and Biodiversity Planet Earth
		An introduction to the classification of living things (similarities and differences of interpretation of species and kinships).	Evolution and Biodiversity
		To describe how animals obtain their food from plants and other animals, using the idea of a simple food chain.	Evolution and Biodiversity Energy Transformation
		To identify that humans and some other animals have skeletons and muscles for support, protection and movement.	Evolution and Biodiversity Organisms and Life Forms
	Other Topics	Orientation	Our Universe Planet Earth
8 to 9	Materials, processes and states of matter	About different physical phenomena, including materials change of state when they are heated or cooled.	Structure of Matter Energy Transformation
		About evaporation and condensation in the water cycle.	Structure of Matter Energy Transformation
		About mixtures and solutions.	Structure of Matter Energy Transformation
		The basics about magnetic forces (how magnets attract or repel each other, etc.).	Fundamental Forces
		To do simple experiments with light and magnets.	Fundamental Forces Microcosm
		To identify how sounds are made and to recognise that vibrations from sounds travel.	Energy Transformation Fundamental Forces
	Space and time	About the sky and Earth. About the movement of Earth (and the other planets) around the sun, Earth's rotation, the length of day, and how it changes with the seasons, and the movement of the Moon around Earth.	Our Universe Planet Earth
		About volcanoes and earthquakes, and the risks they present to human societies.	Planet Earth Evolution and Biodiversity

	Plants and nature	About the evolution of an environment managed by humans (e.g., forests) and the importance of biodiversity.	Evolution and Biodiversity Planet Earth
		To recognise that environments can change and that this can sometimes pose dangers to living things.	Planet Earth Evolution and Biodiversity
	Animals and humans	To construct and interpret a variety of food chains, identifying producers, predators and prey.	Planet Earth Evolution and Biodiversity Energy Transformation
		About the functioning of the human body and health. To describe simple functions of the basic parts of the digestive system in humans.	Organisms and Life Forms
		About body movement (muscles, bones, and joints).	Organisms and Life Forms
		An introduction to metabolic functions—digestion, breathing, and blood circulation.	Organisms and Life Forms Energy Transformation
		About human reproduction and sex education.	Evolution and Biodiversity Organisms and Life Forms
	Other topics	To identify common appliances that run on electricity.	Energy Transformation Fundamental Forces
		To Recognise some common conductors and insulators, and associate metals with being good conductors.	Structure Of Matter Microcosm Energy Transformation
		To construct a simple series electrical circuits. To name and identify its basic parts (cells, wires, bulbs, switches and buzzers).	Energy Transformation Fundamental Forces
		Basic mechanics and results of simple experiments with levers, pulleys, springs, and elastic materials.	Energy Transformation Fundamental Forces
9 to 10	Materials, processes and states of matter	To compare and group together everyday materials based on their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal).	Structure Of Matter

		To know that some materials will dissolve in liquid to form a solution, and to describe how to recover a substance from a solution.	Structure Of Matter Microcosm
		To demonstrate that dissolving, mixing and changes of state are reversible changes.	Structure Of Matter Energy Transformation Microcosm
		About energy production and how it affects the environment. About the use of renewable sources of energy.	Energy Transformation Planet Earth
		To Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.	Fundamental Forces
		About the use of nuclear energy, green energy, biomass and photovoltaic and wind power.	Energy Transformation Planet Earth Microcosm
		About the force of gravity acting between the Earth and a falling object.	Fundamental Forces Our Universe
		About Management of solid and other types of waste.	Planet Earth
	Space and time	About Earth's shape, the moon's phases, and the locations of Earth and the moon in the solar system.	Our Universe Planet Earth
		About climate zones and greenhouse effect.	Planet Earth Energy Transformation
	Plants and nature	About national parks and protected areas.	Planet Earth
		About changes in biodiversity, introduction of new species, extinction of species.	Evolution and Biodiversity Planet Earth
		About recognition classification systems related to biodiversity.	Evolution and Biodiversity Planet Earth
		Further information about the classification of species and organisms.	Evolution and Biodiversity Planet Earth
		About environmental imbalances due to human activities.	Planet Earth
		About the water cycle (how groundwater and water springs develop).	Planet Earth
	Animals and humans	Living things and their habitats. Study of bones and skeletal structure and its functions, the study of the muscular system	Organism and Life Forms

		and its functions, and the study of the skin and its functions.	Evolution and Biodiversity
		To describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird.	Evolution and Biodiversity Organism and Life Forms
		To Describe the life process of reproduction in some plants and animals. Animals, including humans.	Evolution and Biodiversity Organism and Life Forms
		To describe the changes as humans develop to old age.	Organism and Life Forms
	Other topics	To recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.	Fundamental Forces
10 to 11/12	Materials, processes and states of matter	About basic characteristics of objects (mass, volume, density).	Structure Of Matter
		About molecules and how they affect different objects' characteristics.	Structure Of Matter
		To describe electricity related phenomena by using molecules.	Structure Of Matter Microcosm
		About acids and their properties.	Structure Of Matter
		To define forces (motion, etc.) and how they are applied.	Fundamental Forces Energy Transformation
		How energy is never lost and how it changes forms and it is stored.	Energy Transformation
		About the relation between electricity and magnetism; about ardency.	Fundamental Forces
	Space and time	To recognise that light appears to travel in straight lines.	Structure Of Matter
	Plants and nature	About cells as the basic unit of life.	Organism And Life Forms
		About the hierarchical organization of living organisms.	Organism And Life Forms Evolutions And Biodiversity
		About microorganisms and their relation to hygiene and social problems. To further the knowledge about how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including microorganisms.	Evolution And Biodiversity
	Animals and humans	To further the knowledge about how living things are classified into broad groups according to common observable	Evolution And Biodiversity

		characteristics and based on similarities and differences, including micro-organisms.	
		About adaptation of animals and how this may lead to evolution.	Evolution And Biodiversity
		To identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood.	Organisms And Life Forms
		The impact of diet, exercise, drugs and lifestyle on the way their bodies function.	Organisms And Life Forms
	Other topics	To compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches.	Energy Transformation
		To use recognised symbols when representing a simple circuit in a diagram.	-

6.1.2 Mathematics

The following results are the output of the primary curriculum analysis of all 10 countries for the subject of mathematics:

Age	Numbers and calculations	Measurement	Geometry	Algebra	Data collection and interpretation
5 - 6	**Pupils learn:** • to recognize, read, write, compare, order two digits natural numbers; • to read, write and interpret mathematical statements involving addition (+), subtraction (–) and equals (=) signs; • addition and subtraction: how to solve one-step problems that involve addition and subtraction; • to understand simple fractions.	**Pupils learn:** • to measure, compare, describe and solve simple practical problems for: lengths and heights, capacity and volume, time; • recognise and know the value of different denominations of coins and notes; • recognise and use language relating to dates, including days of the week, weeks, months and years; • tell the time (including time	**Pupils learn:** • how to describe the position and direction of movement of an object; • how to recognise and name the basic two dimensional and three dimensional objects	**Pupils learn:** • how to sort different simple objects by using certain criteria; • the concept of equality and inequality.	

		frames: half past the hour, quarter to, etc.); draw the hands on a clock face to demonstrate and recognise them; • recognise and name basic shapes (circle, rectangular, square, triangle)			
6 - 7	**Pupils learn:** • to recognize, read, write, compare, order natural numbers of up to 3 digits • compare and order numbers using <, > and = signs; • the multiplication tables (2,3,4,5,10), including recognising odd and even numbers; • to solve problems involving simple multiplication and division; • to recognise and use the inverse relationship between addition and subtraction; • to add and subtract numbers using concrete objects, pictorial representations, and mentally	**Pupils learn:** • choose and use appropriate standard units to estimate and measure: length/height (m/cm); mass (kg/g); temperature (°C), capacity (litres/ml) to the nearest appropriate unit, using rulers, scales, thermometers and measuring vessels; • compare and order lengths, mass, volume/capacity and record the results using >, < and =	**Pupils learn:** • the basic properties of rectangular and square how to identify and name the different angles • three dimensional objects and associate them with their environment; • are introduced to the concept of symmetry.	**Pupils learn:** • how to solve equations by using the concepts of equality and inequality, by calculating the value of x	**Pupils learn:** • interpret and construct simple pictograms, tally charts, block diagrams and simple tables • ask and answer simple questions by counting the number of objects in each category and sorting the categories by quantity • ask and answer questions about totalling and comparing data

7 - 8	**Pupils learn:** • to recognize, read, write, compare, order four digit numbers; • to round up numbers to the nearest 10, 100, 1000 • how add and subtract three digit numbers • how to multiply one digit numbers with 10, 100, 1000 • how to solve problems by combining addition and multiplication, and the concept of division • to count from 0 in multiples of 4, 8, 50 and 100; • find 10 or 100 more or less than a given number • recognise the place value of each digit in a three-digit number (hundreds, tens, ones) • compare and order numbers up to 1000 • Identify, represent and estimate numbers using different representations.	**Pupils learn:** • the concept of volume; • how to estimate and then measure the perimeter and area of a rectangular and square; • to recognise the relation between time units i.e. 1 day = 24 hours, 1 hours = 60 minutes) the relation among the various coins and notes.	**Pupils learn:** • to identify the various polygons; • to identify three dimensional shapes (i.e. cone; cylinder, sphere, pyramid etc.); • to name the different types of angles; • the four cardinal directions (north, south, east, west).	**Pupils learn:** • how to classify events as certain, possible and impossible to happen	**Pupils learn:** • to use common representations of data (e.g., tables and graphs)

8 - 9	**Pupils learn:** • to recognize, read, write, compare, order, round up, add and subtract numbers up to 1 000 000 • to multiply and divide long numbers; • the concept of decimal numbers and how to convert fractions to decimal numbers; • how to compare numbers with the same number of decimal places up to two decimal places; • how to present numbers as fractions, how to covert fractions in decimal numbers and how to compare fractions • how to add and subtract fractions and solve simple measure and money problems involving fractions and decimals to two decimal places	**Pupils learn:** • how to use the correct measurement units for length, volume and capacity • the relation between the different length units • how to calculate the volume of a rectangular prism • how to calculate the perimeter and the area of rectangular and right triangle • how to write monetary amounts in decimal form; • the concepts of year, decade and century; • how to solve problems using the concepts of time (hour, minutes, seconds)	**Pupils learn:** • practice on designing, reproducing and recognising different shapes and their properties • the concepts of facet, right angle, vortex, edge; • how to complete the symmetry of a shape; • describe positions on a 2-D grid as coordinates in the first quadrant; • describe movements between positions as translations of a given unit to the left/right and up/down; • plot specified points and draw sides to complete a given polygon.	**Pupils learn:** • how to recognise numerical patterns and build on them	**Pupils learn:** • solve comparison, sum and difference problems using information presented in bar charts, pictograms, tables and other graphs.

9 - 10	**Pupils learn:** • to recognize, read, write, compare, order numbers up to 1 000 000 000; • about negative numbers; • how to simplify fractions; • how to compare, add and subtract proper and improper fractions; • how to convert fractions to decimal numbers; • how to multiply a natural number with a fraction; • the methodology of long division; • how to recognise the per cent symbol (%) and understand that per cent relates to 'number of parts per hundred'	**Pupils learn:** • how to use the correct measurement units for length, volume and mass; • conversions between the different units; • how to calculate the area and perimeter of rectangular, square and triangles with the use of formulas; • solve problems involving converting between units of time; • how to measure angles using the right tools.	**Pupils learn:** • the design on three dimensional shapes using the appropriate methodology • how to calculate the perimeter of different shapes	**Pupils learn:** • how to describe patterns and investigate the relations among different patterns; • how to create graphs, about the minimum, maximum and average value	**Pupils learn:** • how to collect, classify, represent and interpret data • are introduced to the concept of probabilities

10 - 11	**Pupils learn:** • to recognize, read, write, compare, order numbers up to 9 digits; • the concept of negative numbers; • to work and solve problems with percentages; • deepen their understanding on long division; • how to divide and multiply fractions; • the concept of analogy and how to how to graphically represent analogy; • the concept of numerical powers and the power of 10.	**Pupils learn:** • how to calculate the area of a parallelogram and the extended area of three dimensional objects ; • about the summary of polygon angles; • solve problems involving the calculation and conversion of units of measure, using decimal notation up to three decimal places; • use, read, write and convert between standard units; • calculate, estimate and compare volume of cubes and cuboids using standard units, including cubic centimetres (cm3) and cubic metres (m3), and extending to other units [for example, mm3 and km3].	**Pupils learn:** • about the properties of triangles and their secondary elements i.e. median, altitude; • the properties of circles; to recognise, classify and construct two and three dimensional shapes by using the appropriate instruments	**Pupils learn:** • how express powers; • how to simplify mathematical expressions; • how to solve equations; • about the priorities in performing the various calculations .	**Pupils learn:** • how to create charts and how to interpret them • how to compose hypothesis and how to calculate the average
11 -12	**Pupils are expected to know:** • how to read, write and order all natural, fractional and decimal numbers plus carry out all possible calculations.	**Pupils:** • are reminded how to use the various measurement units and how to use them in day to day life; • learn how to compose a rule for a simple numerical and geometrical motif	**Pupils:** • are reminded how to use the various measurement units and how to use them in day to day life; • learn how to calculate the perimeter and area of a circle plus	**Pupils are expected to know:** • how to solve equations;	**Pupils learn:** • how to create and interpret different types of charts; • how to calculate averages, compose hypothesis an solve equations

			the areas and volumes of three dimensional objects learn how to reproduce, draw and compare different angles • learn how to scale images up or down		

6.2 Curriculum analysis secondary education results

The following results are the output of the secondary curriculum analysis for all 11 countries.

6.2.1 Biology (Natural sciences)

The following results are the output of the curriculum analysis of all 11 countries for the subjects of biology:

Age	Subject	Topic	Big Ideas of Science
12-15	Cells and organisms	Students learn that an organism is composed by different organizational levels (cell, tissue, organs, systems, organisms)	Organisms And Life Forms
12-15	Cells and organisms	Students recognize cells as the building blocks of an organism and recognize its structure on microscopic level	Organisms And Life Forms
12-15	Cells and organisms	Students learn about the functions of the cell wall, cell membrane, cytoplasm, nucleus, vacuole, mitochondria and chloroplasts	Organisms And Life Forms Energy Transformation
12-15	Reproduction	Students learn about the female and male reproduction organs	Evolution and Biodiversity
12-15	Reproduction	Students learn about the reproductive system of humans (how it happens, conditions)	Evolution and Biodiversity
12-15	Reproduction	Students learn about reproduction of plants including flower structure, wind and insect pollination	Evolution and Biodiversity
12-15	Plants	Students learn about plants' different parts and what they need to grow	Organisms And Life Forms Energy Conservation

12-15	Photosynthesis	Students learn about the process of photosynthesis , its importance and the different factors that affect its completion	Organisms And Life Forms Energy Conservation
12-15	Nutrition	Students learn about the content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water, and why each is needed	Biodiversity and Evolution Planet Earth
12-15	Digestive system	Students learn how our digestive system is structured and operates	Organisms and Life Forms Energy Conservation
15-18	Digestive system	Students learn about metabolism (how energy is transferred to cells)	Organisms and Life Forms Energy Conservation
15-18	Digestive system	Students learn about enzymes and cell breathing	Organisms and Life Forms Energy Conservation
13-16	Digestive system	Students learn about the importance of bacteria in the human digestive system	Organisms and Life Forms
12-15	Respiratory system	Students learn about the mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume	Organisms and Life Forms Fundamental Forces
15-18	DNA	Students learn about DNA structure and DNA transfer	Organisms and Life Forms Evolution and Biodiversity
12-15	Human body	Students learn about the structure and functions of the human skeleton, to include support, protection, movement and making blood cells	Organisms and Life Forms Evolutions and Biodiversity
13-16	Human body	Students learn about biomechanics – the interaction between skeleton and muscles, including the measurement of force exerted by different muscles	Organisms and Life Forms Fundamental Forces

6.2.2 Geography

The following results are the output of the curriculum analysis of all 11 countries for the subject of geography:

Age	Subject	Topic	Big Ideas of Science

12-15	Orientation	Students learn how to read maps using legends, scale and orientation	Planet Earth Our Universe
12-15	Orientation	Students learn about orientation and geographical coordinates	Planet Earth
12-15	Weather & climate	Students learn about the similarities and differences between weather and climate	Planet Earth Energy Transformation
12-15	Weather & climate	Students learn to read weather and climate data for a specific area with the use of graphics, maps and measurements	Planet Earth
12-15	Weather & climate	Students learn about Earth's position in our solar system, its movement and how it connects to climate	Our Universe Planet Earth
12-15	Weather & climate	Students learn about climate and factors that affect it	Planet Earth Our Universe
12-15	Weather & climate	Students learn about Earth's environmental problems, climate change and its impact on humans and our planet	Planet Earth Evolution and Biodiversity

6.2.3 Chemistry

The following results are the output of the curriculum analysis of all 11 countries for the subject of chemistry:

Age	Subject	Topic	Big Ideas of Science
12-15	Matter	Students learn about the particulate nature of matter, the properties of the different states of matter (solid, liquid and gas) in terms of the particle model, including gas pressure and changes of state in terms of the particle model.	Structure Of Matter
12-15		Students learn about atoms, elements and compounds, the differences between atoms, elements and compounds	Structure Of Matter Microcosm
12-15	Matter	Students learn about elements and chemical reactions (i.e.; the composition of mixtures, homogeneous and heterogeneous mixtures and their characteristics)	Structure Of Matter Microcosm Energy Transformation
12-15	Mixtures	Students learn about dissolving diffusing mixtures in terms of the particle model simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography. Students also learn about the identification of pure substances.	Structure Of Matter

15-17	Dissolution process	Students learn to describe the creation of solutions (in case of ionic and covalent substances)	Structure Of Matter Energy Transformation Fundamental Forces
15-17	Dissolution process	Students learn to differentiate between electrolytes and non-electrolytes and strong and weak electrolytes	Structure Of Matter
15-17	Dissolution process	Students learn to explain the concepts of acid and base on the basis of proteolytical theory	Structure Of Matter
15-17	Dissolution process	Students learn to calculate molecular concentration	Structure Of Matter
15-17	Dissolution process	Students learn to create formula for interionic reactions (in molecular and ionic form);	Structure Of Matter Energy Transformation
15-17	Dissolution process	Students learn to evaluate and justify the environment created in the solution by dissolving different substances in water	Structure Of Matter
15-17	Dissolution process	Students learn to describe the creation of solutions (in case of ionic and covalent substances)	Structure Of Matter Fundamental Forces
15-17	Chemical reactions	Students learn how to represent them using formulas and equations	Structure of Matter Energy Transformation
15-17	Chemical reactions	Students learn to associate a chemical reaction with particles crossing over to a more permanent state	Structure of Matter Energy Transformation
15-17	Chemical reactions	Students learn to explain the thermal effects of chemical reactions on the basis of changes in energy occurring when chemical bonds are formed or disintegrated	Structure of Matter Energy Transformation
15-17	Chemical reactions	Students learn to analyse the effects of factors affecting the speed of a chemical reactions and explain the changes in the speed of chemical processes in everyday life	Structure of Matter Energy Transformation
15-17	Chemical reactions	Students learn to understand that in case of reversible reaction, there will be an equilibrium	Structure of Matter Energy Transformation
13-16	pH	Students learn about the pH scale for measuring acidity/alkalinity; and indicators.	Structure of Matter
13-16	Acids	Students learn about the reactions of acids with metals to produce a salt plus hydrogen. They also learn about the	Structure of Matter Fundamental Forces

		reactions of acids with alkalis to produce a salt plus water	
13-16	Catalysts	Students learn about what catalysts do.	Structure of Matter Energy Transformation
15-17	Periodic table	Students learn about the periodic table and the varying physical and chemical properties of different elements	Structure of Matter
15-17	Earth atmosphere	Students learn about Earth and its atmosphere. They learn about the composition of Earth, its structure, the formation of rocks, its resources	Structure of Matter Planter Earth
15-17	Carbon dioxide	Students learn about the production of carbon dioxide by human activity and the impact on climate	Structure of Matter Planter Earth

6.2.4 Physics

The following results are the output of the curriculum analysis of all 11 countries for the subject of physics:

Age	Subject	Topic	Big Ideas of Science
12-15	Energy transfers	Students learn how heating and thermal equilibrium: temperature difference between two objects leads to energy transfer from the hotter to the cooler one, through contact (conduction) or radiation. Such transfers tend to reduce the temperature difference: use of insulators Students also learn about other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels.	Energy Transformation Structure of Matter Planet Earth Our Universe
12-15	Changes in systems	Students learn about energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change. Students compare the starting with the final conditions of a system and describe increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions	Energy Transformation Fundamental Forces Planet Earth Our Universe
12-15	Describing motion	Students learn about speed and the quantitative relationship between average speed, distance and time (speed = distance ÷ time). They also learn about the representation of a journey on a	Fundamental Forces

		distance-time graph and relative motion: trains and cars passing one another.	
15-17	Motion	understand that the physical quantities length (also distance), time interval (Δt) and time (t) are based on comparison of objects and their mutual motion (processes)	Fundamental Forces Our Universe
15-17	Motion	know that the state of motion of an body is characterised by velocity and give examples of the relativity of motion in the macro world;	Fundamental Forces
15-17	Motion	know the main difference between relative physics and classical physics	Fundamental Forces Our Universe
15-17	Motion	know that a field is always moving with the highest possible velocity, i.e. absolute velocity with regard to matter	Fundamental Forces Energy Transformation
15-17	Motion	differentiate between scalar and vector quantities and give examples of them	-
15-17	Motion	explain the meaning of the minus sign in physics formulas (the direction changing to the opposite of the original direction)	-
15-17	Motion	differentiate between the important characteristics of phenomena such as even linear motion, evenly accelerating liner motion, evenly decelerating linear motion and free falling and bring appropriate examples	Fundamental Forces Energy Transformation
15-17	Motion	explain the meanings of physical quantities such as velocity, acceleration, distance and displacement and identify the methods of measuring and finding these quantities	Fundamental Forces Energy Transformation
15-17	Motion	solve problem tasks applying the definitions and ; describe constant liner motion and uniformly changing motion by respective motion formulas	Fundamental Forces Energy Transformation
15-17	Motion	analyse the charts of velocity and distance of constant and uniformly changing linear motion; be able to find the distance as the surface area in the velocity chart	Fundamental Forces
15-17	Motion	implement the following associations for finding the velocity, displacement and acceleration of uniformly changing linear motion, including free falling.	Fundamental Forces
12-15	Forces	Students learn about forces as pushes or pulls, arising from the interaction between two objects. They also learn to use force arrows in diagrams, adding	Fundamental Forces

		forces in one dimension, balanced and unbalanced forces	
12-15	Forces	Students learn about forces: associated with deforming objects; stretching and squashing – springs; with rubbing and friction between surfaces, with pushing things out of the way; resistance to motion of air and water. They also learn that forces are measured in newtons, and energy changes on deformation	Fundamental Forces Energy Transformation
12-15	Forces	Students learn about non-contact forces: gravity forces acting at a distance on Earth and in space, forces between magnets and forces due to static electricity.	Fundamental Forces Our Universe Structure of Matter Microcosm
15-17	Forces	Students learn about forces and fields: electrostatic, magnetic, gravity. They also learn about forces as vectors and how to calculate work done as force x distance; elastic and inelastic stretching. They learn about how pressure in fluids acts in all directions: variation in Earth's atmosphere with height, with depth for liquids, up-thrust force (qualitative).	Fundamental Forces Our Universe Planet Earth
12-15	Forces and motion	Students learn about forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (qualitative only). Change depends on direction of force and its size.	Fundamental Forces
15-17	Forces and motion	Students learn about the speed of sound and how to estimate speeds and accelerations in everyday contexts. They also learn how to interpret quantitatively graphs of distance, time, and speed. They learn that acceleration is caused by forces through Newton's Second Law and about decelerations and braking distances involved on roads.	Fundamental Forces
12-15	Waves	Students learn that the frequencies of sound waves, measured in hertz (Hz). They also learn about echoes, reflection and absorption of sound	Fundamental Forces Energy Transformation
12-15	Waves	Students learn about how sound needs a medium to travel, about the speed of sound in air, in water, in solids They also learn that sound is produced by vibrations of objects, in loud speakers and is detected by their effects on microphone diaphragm and the eardrum. Sound waves are longitudinal.	Fundamental Forces Energy Transformation
15-17	Waves	Students learn about amplitude, wavelength, frequency and how to relate	Fundamental Forces

		velocity to frequency. They learn about transverse and longitudinal waves, electromagnetic waves and their velocity in vacuum. They also learn about how waves transfer energy, wavelengths, and frequencies from radio to gamma rays.	Energy Transformation
15-17	Waves	Students learn about velocities differing between media: absorption, reflection, refraction effects. They learn about production and detection, by electrical circuits, or by changes in atoms and nuclei. They also learn about uses in the radio, microwave, infrared, visible, ultra-violet, X-ray and gamma-ray regions and hazardous effects on bodily tissues.	Fundamental Forces Energy Transformation Microcosm
12-15	Light waves	Students learn about the similarities and differences between light waves and waves in matter. They also learn about how light waves travel through a vacuum and speed of light	Energy Transformation Microcosm
12-15	Light waves	Students learn about the transmission of light through materials: absorption, diffuse scattering and specular reflection at a surface	Energy Transformation Microcosm
12-15	Current electricity	Students learn about the electric current, measured in amperes, in circuits, series and parallel circuits. They learn about how currents add where branches meet and about current as flow of charge. They also learn about how potential differences are measured in volts, about battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current differences in resistance between conducting and insulating components (quantitative).	Energy Transformation Structure of Matter Fundamental Forces Microcosm
12-15	Static electricity	Students learn about the separation of positive or negative charges when objects are rubbed together: transfer of electrons, forces between charged objects. They also lean about the idea of electric field, forces acting across the space between objects not in contact.	Structure of Matter Fundamental Forces Microcosm
15-17	Electricity	Students explore current, resistance and voltage relationships for different circuit elements, including their graphical representations	Structure of Matter Fundamental Forces Microcosm
15-17	Electricity	Students learn about power transfer related to partial discharge and current or current and resistance.	Energy Transformation Structure of Matter Fundamental Forces

15-17	Electric fields	explain terms charge, current and amperage and the meaning of the formula I= q/t; 2) 3) associate the electrostatic field with the existence of a charged body by applying the formula ; 4)	Energy Transformation Structure of Matter Fundamental Forces
15-17	Electric fields	compare terms matter and field;	Energy Conservation Microcosm
15-17		associate the electrostatic field with the existence of a charged body by applying the formula E= F/q	Fundamental Forces Microcosm
15-17	Electric fields	use Coulomb's law for solving problems $F = k\frac{q_a q_b}{r^2}$	Fundamental Forces
15-17	Electric fields	use the principle of superposition for constructing the E-vector of an electrostatic field at a given point	Fundamental Forces
15-17	Electric fields	know that a homogenous electric field is created between two parallel charge-carrying plates with different charges	Fundamental Forces Energy Transformation
15-17	Electric fields	know that there are two principally different causes for magnetic fields: permanent magnets and current-carrying wires) and apply the formula	Fundamental Forces Energy Transformation Structure of Matter
15-17	Electric fields	apply Ampere's law for solving problems;	Fundamental Forces
15-17	Electric fields	determine the direction of magnetic induction created by a straight wire in a given point;;	Fundamental Forces Structure of Matter
15-17	Electric fields	use the formula F = B I l sin α and Ampere's rules for determining the direction of a force;	Fundamental Forces
15-17	Electric fields	apply the Lorentz force formula FL = q v B sin α for solving problems and determine the direction of Lorentz force	Fundamental Forces
15-17	Electric fields	explain the creation of a electrodynamic field upon changes in the magnetic flux by applying the definition of the electromotive force of induction;	Fundamental Forces Microcosm Structure of Matter
12-15	Magnetism	Students learn about magnetic poles, attraction and repulsion. They also learn about magnetic fields by plotting with compass, representation by field lines. They learn about Earth's magnetism, compass and navigation and the magnetic effect of a current. Electromagnets and D.C. motors are also visited	Fundamental Forces Energy Transformation Planet Earth

15-17	Magnetism	Students explore the magnetic fields of permanent and induced magnets, and the Earth's magnetic field, using a compass. They learn about the magnetic effects of currents and how solenoids enhance the effect. How transformers are used in the national grid and the reasons for their use are also discussed.	Fundamental Forces Energy Transformation Planet Earth
12-15	Physical changes	Students learn about the conservation of material and of mass, and reversibility, in melting, freezing, evaporation, sublimation, condensation, dissolving	Energy Transformation Fundamental Forces Structure Of Matter
12-15	Physical changes	Students learn about similarities and differences, including density differences, between solids, liquids and gases. They also learn about diffusion in liquids and gases driven by differences in concentration and the difference between chemical and physical changes.	Energy Transformation Fundamental Forces Structure Of Matter
14-17	Scientific thinking	Students learn about the ways in which scientific methods and theories develop over time. They also learn to appreciate the power and limitations of science and consider ethical issues which may arise	-
15-17	Analysis and evaluation	Students learn how to apply the cycle of collecting, presenting and analysing data, including the presentation of observations and other data using appropriate methods. They also learn to translate data from one form to another along with carrying out and representing mathematical and statistical analysis	-
15-17	Mechanics	Students learn to explain the occurrence of phenomena interaction, gravitation, friction and deformation and their application in nature;	Fundamental Forces Energy Transformation
15-17	Mechanics	Students learn to supplement a given figure with vectors showing the forces affecting a body both when the state of motion is constant (v = const, a = 0) or changing (a = const ≠ 0);	Fundamental Forces
15-17	Mechanics	Students learn to find the net force trough force components	Fundamental Forces
15-17	Mechanics	Students learn to explain and apply Newton's laws and associate them with everyday phenomena	Fundamental Forces Planet earth Our Universe
15-17	Mechanics	Students learn to formulate the law of conservation of momentum and solve problem tasks using the relationship	Fundamental Forces

15-17	Mechanics	Students learn to associate reactive motion with the law of conservation of momentum, give examples of reactive motion in nature and its implications in technology	Fundamental Forces
15-17	Mechanics	Students learn to give examples about phenomena where the velocity of the momentum changing is equal with the force causing the change	Fundamental Forces
15-17	Mechanics	Students learn to apply the Law of Gravitation	Fundamental Forces Our Universe
15-17	Mechanics	Students learn to know the definition of field of gravity	Fundamental Forces Our Universe
15-17	Mechanics	Students learn to know that general theory of relativity describes the gravitational interaction through bending space-time;	Fundamental Forces Our Universe
15-17	Mechanics	use terms gravitation, weight of body, reaction of supports, stress and pressure when solving problem tasks and applies the relation P = m (g ± a)	Fundamental Forces
15-17	Mechanics	explain terms friction force and elastic force and when explaining phenomena occurring in natural and artificial environments, applies the relations Fh = μ N and Fe = – k Δl	Fundamental Forces
15-17	Mechanics	apply terms work, energy, kinetic and potential energy, power, output energy, energy conversion efficiency when explaining phenomena in nature and artificial environments	Energy Transformation

6.2.5 Mathematics

The following results are the output of the curriculum analysis of all 11 countries for the subjects of mathematics:

Age	Subject	Topic
12-15	Algebra – Real numbers	Students learn the properties of exponents where the index is a natural number
12-15	Algebra – Real numbers	Students learn about rational numbers raised to integer exponents
12-15	Algebra – Real numbers	Students learn about square and cubic roots
12-15	Algebra – Real numbers	Students learn about properties of roots
12-15	Equations	Students learn to use letters as unknowns
12-15	Equations	Students learn to solve first degree equations with one unknown
12-15	Equations	Students learn to respond to simple questions that can be deduced from a first degree equation

12-15	Statistics	Students learn how to use simple schemas, figures, tables and diagrams
12-15	Geometry	Students learn to recognise parallel & perpendicular position and symmetry in flat figures
12-15	Geometry	Students learn about the properties of parallelograms
12-15	Geometry	Students learn about the properties of orthogonal parallelograms
12-15	Geometry	Students learn to recognise rhombuses and their properties
12-15	Geometry	Students learn about squares and their properties
12-15	Geometry	Students learn about trapezoids and their properties
12-15	Geometry	Students learn about the properties of circles and how to calculate their circumference
12-15	Geometry	Students learn to calculate the area of a disk
12-15	Geometry	Students learn to calculate the circumference and area of triangles, quadrilaterals and circles
12-15	Measuring distances	Students learn to use suitable units an instruments to measure distances and angles with accuracy
12-15	Scales	Students learn how to work with and determine scales
15-17	Trigonometry	Generalisation of the term ‘angle’, radian measure. Trigonometric functions ( ) of any angle, and their values if the angles are of 00, 300, 450, 600, 900, 1800, 2700 or 3600. Trigonometric functions of negative angles.
15-17	Trigonometry	Graphs of y = sin x, y = cosx and y = tan x functions. Fundamental relations of trigonometry: $\alpha\ \alpha\ \alpha$ cos sin tan = , sin cos 1 2 2 $\alpha + \alpha =$, cos sin(90) 0 $\alpha = -\alpha$, sin cos(90) 0 $\alpha = -\alpha$, tan(90) 1 tan 0 $\alpha\ \alpha - =$, sin($-\alpha$) = $-\sin\alpha$, cos($-\alpha$) = $\cos\alpha$, tan($-\alpha$) = $-\tan\alpha$, sin(α 360) sinα 0 + k · = , cos(α 360) cosα 0 + k · = , tan(α 360) tanα 0 + k · = . Sine and cosine 9 theorem
15-17	Functions	Functions y = ax + b, y = ax + bx + c 2 and x a y = (review). Term and general symbol of a function Methods presentation of functions. Domain and range of a functions. Even and odd functions. Zeros of a function, Domain of positivity and negativity of a function. Increase and decrease of a function. Extreme of functions.
15-17	Functions	Functions n y = ax (n =1, 2, –1 ja –2). The term ‘logarithm of a number’. Logarithm of a product, quotient and power. Finding the logarithm and potentiating (to an extent that enables pupils to solve simpler exponent and logarithmic equations). Inverse function.
15-17	Functions	Functions x y = a and y x a = log. Increase and decrease by compound interest. Examples of models containing ax e. Simpler exponent and logarithmic equations. The terms arcsin m, arccos m and arctan m. Examples of finding solutions to main trigonometric equations.

7. Teacher organisations training needs for primary and secondary education

As it has already been introduced in D1.1, the role of the Teacher Training Institutes (TTIs) framework gain understanding of the precise needs of teacher training organizations in terms of support and specific material with practical examples on the use of IBL for subjects. ILSs, laboratories, specific presentations are some of the materials that the project has been developing and provided to the TTIs in order to ease the introduction of IBL and Go-Lab to their curricula. As a result of the first meeting with the TTIs which took place in Brussels, Belgium on 20th June 2017 and the following online meeting and workshops organized, a number of needs have been identified for in order to foster the TTIs involvement, Go-Lab inclusion in their teaching programmes and thus, further expansion of the programme:

- **"A universal adapter".** The ecosystem was understood as a very suitable tool for their organizations to be able to include IBL approaches in their programmes while respecting the curriculum.
- **Benefits of IBL.** A clear emphasis of the benefits of inquiry-based learning (IBL), in general, and Go-Lab, in particular, when confronting the "innovative vs traditional" education dilemma.
- **Consistent merge of the Go-Lab Ecosystem** (Go-Lab + Graasp). Easy and understandable linkage between both platforms that should also include teacher profiling.[18]
- **Evaluation and implementation follow up**. Most our TTIs are also research organizations. The representatives were especially interested in the possibility of being able to measure the results of the programme implementation themselves.
- **Student thesis collaborations**. Some of the TTIs are aiming to involve their students in writing Go-Lab implementation and curriculum analysis related topics for their master thesis.
- **Introduction of new subjects** and cross-disciplinary ILSs. Encouraging school dissemination of the Ecosystem across different subjects and ages.
- **Possible support materials** suggested by the TTIs:
  - Possibility of tool customization for schools.
  - Organization of Graasp trainings targeting specific demands.
  - Special access for universities – Single sign-on (SSO)
  - Expert Teachers Support.
  - Tutorials in national languages i.e. adding subtitles to existing tutorials.
  - Development of more interdisciplinary ILSs.
  - Visual materials of real implementations.
  - Guide: "How to implement ILS" and Go-lab as a part/example of this guide.

[18] The technical team is constantly implementing new developments in this regard, ensuring a smooth transition between both platforms. In addition, teacher profiling will be enabled through Graasp, in order for teachers to be able to search ILS, Apps and Labs without having to switch from one platform to another while providing an easy access to related content.

A follow up questionnaire was also provided to the TTIs after our first face-to-face meetings, below you may find some of the quotes by the TTIs representatives in relation to their needs:

"More training on how to use Go-Lab and/or support from an expert in Go-Lab. Evidences about the added value of Go-Lab."

University of Coimbra

"Examples of how Go-Lab is being used in practice in both schools and TTIs. I can see that Go-Lab could fit nicely into many of our courses and in-school training, but the other teachers need specific examples of how it has been done in other places. Another important thing is research about the effectiveness of using Go-Lab (or IBL in digital environments in general)."

University of Turku

"Methodical material where teachers share experiences".

Riga Technical University - Distance Education Study Centre

"I liked the idea of infographics what was discussed at the meeting."

Tartu Ulikool

The section above presents a summary of the teacher organizations needs for primary and secondary implementations. Further details on the materials and support activities developed by the Next-Lab project for the TTIs framework maybe be found in D1.3.

8. Conclusions

The exercise of the curriculum analysis, which has covered the primary and secondary curricula of 11 countries, has been organised in different phases and by taking into account, the particularities of each educational system i.e. different age levels, subjects and national priorities.

In primary education, the majority of common topics have been identified under the subjects of Mathematics and Sciences, which included elements from nature and plants, material processes and states of matter, space and time and finally, animals and humans.

In secondary education, where the issue of age was more prominent, common topics have mainly been identified under the subjects of Mathematics, Physics, Chemistry, Geography and Biology.

The curriculum analysis results as they are presented in section 6, along with the suggestions regarding the presence of Big Ideas of Science in the Go-Lab ecosystem, as they are presented in section 5.1, provide a tangible course of action that can follow the implementation of Task 2.5 and the creation of the 60 new ILSs. These ILSs, that will function as an inspiration for the teachers, will be standing out on the one hand, for their educational, scientific and design thoroughness and on the other hand, for their meaningful and continuous sequence. This sequence will be structured in a way that will allow them to form a network of crosscutting, interdisciplinary storylines that intersect the science curriculum achieving its maximum coverage. Ideally, these ILSs will not be sporadically distributed in this common ground but instead, through the Big Ideas methodology, they will be strongly linked to each other forming in this way a network of meaningful sequences that can, in the near future, have a dedicated place within the Go-Lab ecosystem.

9. Annex

9.1 Primary Education

9.1.1 Belgium (Flanders)

9.1.1.1 Mathematics

Topic	Subject
Numbers and calculations ▪ Students learn numbers with one, two, three, four, five digits and the power of 10 ▪ Students learn about different functionalities of numbers i.e. address, postcode, telephone number, digital time etc. ▪ Students learn about fractions and their meaning (i.e. 9/10 of our body is water) and how to work with them (addition, subtraction etc.) ▪ Students learn how to recognise, write and order natural numbers up to 10 digits and up to 3 decimals ▪ Students learn how to recognise, name and use the following symbols: : = < > + X . / % ▪ Students learn about other numeral systems i.e. Romans, Arabic, the English mile etc. ▪ Students learn how to perform all basic calculations (addition, subtraction, division) till 100 first and then with larger numbers ▪ Students learn how to round up numbers i.e. 12900 become 13000 ▪ Students learn how to solve problems using the appropriate operation (addition, subtraction, division, multiplication) ▪ Students learn how to perform operation with 8 and 10 digits numbers ▪ Students learn how to calculate percentages ▪ Students learn how to use a calculator ▪ Students learn how to use a calculator to check the outcomes of their basic operations	Mathematics
Measurements ▪ Students learn the units for measuring length, weight, volume, surface, time, temperature and their subdivisions i.e. 1m=10dm ▪ Students learn how to use these measurement units in the appropriate situation i.e. liquids are measured in litres ▪ Students learn how to make conversions from one measurement unit to another ▪ Students learn how to count and use money in real life situations i.e. how to pay, how to calculate and give change ▪ Students learn the difference between seconds, minutes and hours ▪ Students learn how to use and read both the analogue and the digital clocks.	Mathematics
Geometry ▪ Students need to be able to identify all basic two-dimensional (i.e. triangle, square, circle etc.) and three dimensional shapes (cube, pyramid, cylinder etc.) ▪ Students need to know the properties of all previously mentioned shapes ▪ Students need to understand and use correctly the symbols for parallel and intersecting lines	Mathematics

9.1.1.2 Science

Topic	Subject
Nature ▪ Students learn how to categorise organisms based on i.e. usefulness for people, environment they live in. Students also learn how to identify and categorise materials based on: whether they are solids or liquids, their external appearance, colour, smell, hardness, solubility, fragility, permeability of light. ▪ Students learn to name different types of plants and animals that live in forests, rivers and other biotopes. They also learn about the different types of buildings, cultivations and other constructions that people create and their influence to our environment.	Science
Biology and health ▪ Students learn how digestion works and how the body cannot use food that is eaten until it is broken down into very small molecules like protein, vitamins, carbohydrates, and fats. Only then can the body absorbs these molecules and process them through the blood, liver, kidneys, and the entire digestive system, working to separate the good parts from the bad. ▪ The process of growth for teeth and hair along with other processes i.e. menstruation are explained. ▪ Healthy eating habits along with the different food groups and their contribution to our health are extensively discussed. ▪ Students are taught to recognise dangerous situations i.e. fire, accident etc. and respond accordingly. Basic first aid skills i.e. how to treat a fire wound for example are also taught.	Biology
Environment ▪ Students learn how to manage and decrease waste, how to sort it and other choices they can make in order to achieve minimum impact to environment i.e. going to school by bike or public transport ▪ Students learn how to care about their environment by taking care of plants and animals, the main components that guarantee their survival i.e. water, food, clean air, movement and a safe sleeping place. ▪ Students learn how to identify major environmental threats in their immediate environment i.e. pollution from industries, water contamination etc.	Technology
Mechanics ▪ Students are able to identify the mechanical systems around them and their basic components ▪ Students investigate the workings of different technical systems i.e. bicycle, clock, car toy and start to understand how their different parts function together ▪ Students learn about the evolution of technical systems in the course of time i.e. communication (from smoke signals to telegraphy), transport (from carriages to speed trains) etc. ▪ Students are introduced (usually in the form of study trips) to the technical processes related to fruit collection but also to biochemistry/food production. Students identify the various technical system involved in these processes, how the function, their energy requirements. ▪ Students learn how to respond to a problem by following a step-by-step technical approach: identify and understand the problem, think about the possible solution, design the solution, decide on the best implementation order to be followed, take decisions related to materials, functionalities to be added, improvements etc. ▪ Students learn how to evaluate and compare different technical systems based on their properties, by asking questions like: which one is the fastest,	Technology

which provides a better result, which need less materials, which is the safest, which is the most resistant etc.	

9.1.2 Cyprus

9.1.2.1 Mathematics

Topic	Subject (indicative since most of these topics appear under the general topic of Science)
Numbers and calculations: ▪ Students learn to recognize, read, write, compare, order natural numbers till 100 ▪ Students learn to add and subtract using numbers till 100 ▪ Students learn the concepts of multiplication (repeated addition) and division (repeated subtraction) ▪ Students learn to understand what ½, 1/3, ¼ stand for **Measurements** ▪ Students learn how to measure length ▪ Students learn how to measure the perimeter in cm by using the appropriate instruments ▪ Students learn how to recognise the main coins and notes ▪ Students learn the meaning of time and the concepts of today, tomorrow, week and year ▪ Students learn the months of the year **Geometry** ▪ Students learn how to describe the position of an object ▪ Students learn how to recognise and name the basic two dimensional and three dimensional objects **Algebra** ▪ Students learn how to sort different objects by using certain criteria ▪ Students learn the concept of equality	Mathematics (Grade 1)
Numbers and calculations ▪ Students learn to recognize, read, write, compare, order natural numbers till 1000 ▪ Students learn to perform addition and subtraction with numbers till 1000 (while using different methodologies and strategies) ▪ Students learn how to multiply and divide till 20 ▪ Students learn the multiplication tables of 1,2,3,4,5,6,10 **Measurements** ▪ Students learn how to measure length in meters or centimetres with the use of appropriate instruments ▪ Students learn how to measure the perimeter and the area of normal shapes ▪ Students learn how to recognise the main coins and notes and how to solve related problems ▪ Students learn how to write the date and how to read/write time in analogue and digital clocks **Geometry**	Mathematics (Grade 2)

▪ Students learn to recognise and name basic shapes (circle, rectangular, square, triangle) ▪ Students learn the basic properties of rectangular and square ▪ Students learn how to identify and name the different angles ▪ Students learn about three dimensional objects and associate them with their environment **Algebra** ▪ Students learn how to solve equations by using the concepts of equality and inequality, by calculating the value of x ▪ Students learn about the use of 0 and 1 in addition and multiplication **Statistics – probabilities** ▪ Students learn how to organise and present data by using tables and bar charts ▪ Students learn how to interpret data presented in the form of tables and bar charts	
Numbers and calculations ▪ Students learn to recognize, read, write, compare, order numbers till 10000 ▪ Students learn round up numbers to the nearest 10, 100, 1000 ▪ Students learn how add and subtract three digit numbers ▪ Students learn how to multiply one digit numbers with 10, 100, 1000 ▪ Students learn how to solve problems by combining addition and multiplication ▪ Students learn how to compare fractions ▪ Students learn the concept of decimal numbers **Measurements** ▪ Students learn the concept of volume ▪ Students learn how to estimate and then measure the perimeter and area of rectangular and square ▪ Students learn to recognise the relation between time units i.e. 1 day = 24 hours, 1 hours = 60 minutes) ▪ Students learn the relation among the various coins and notes **Geometry** ▪ Students learn to name the different types of angles ▪ Students learn to identify the various polygons ▪ Students learn how to identify three dimensional shapes (i.e. cone; cylinder, sphere, pyramid etc.) ▪ Students learn the four cardinal directions (north, south, east, west) **Algebra** ▪ Students learn how to solve simple equations by using the concept of equality **Statistics – probabilities** ▪ Students learn how to organise and present data by using tables and bar charts ▪ Students learn how to interpret data presented in the form of tables and bar charts ▪ Students learn how to classify events as certain, possible and impossible to happen	Mathematics (Grade 3)
Numbers and calculations ▪ Students learn to recognize, read, write, compare, order numbers till 1 000 000 ▪ Students learn round up numbers to the nearest 10, 100, 1000	Mathematics (Grade 4)

▪ Students learn how add and subtract numbers till 1 000 000 ▪ Students learn multiply and divide long numbers ▪ Students learn how to present numbers as fractions ▪ Students learn how to compare fractions ▪ Students learn the concept of decimal numbers and how to convert fractions to decimal numbers ▪ Students learn how to add and subtract homonymous fractions **Measurements** ▪ Students learn how to use the correct measurement units for length, volume and capacity ▪ Students learn the relation between the different length units ▪ Students learn how to calculate the volume of a rectangular prism ▪ Students learn how to calculate the perimeter and the area of rectangular and right triangle ▪ Students learn how to calculate the perimeter and the area of more complicated shapes ▪ Students learn how to write monetary amounts in decimal form ▪ Students learn the concepts of year, decade and century ▪ Students learn how to solve problems using the concepts of time (hour, minutes, seconds) **Geometry** ▪ Types of lines: parallel and perpendicular ▪ Types of lines: students learn how to draw acute, right and obtuse angles ▪ Students learn about two dimensional and three dimensional geometry ▪ Students learn about symmetry and how to draw the missing symmetrical part of shapes ▪ Students learn how to read and compose coordinates **Algebra** ▪ Students learn how to recognise numerical patterns and build on them ▪ Students learn how to solve problems that require more than one functions ▪ Students learn about transitive property and how to use it **Statistics** ▪ Students learn to interpret pie charts ▪ Students learn how to interpret and construct charts	
Numbers and calculations ▪ Students learn to recognize, read, write, compare, order numbers till 1 000 000 000 ▪ Students learn negative numbers ▪ Students learn how to simplify fractions ▪ Students learn how to compare, add and subtract proper and improper fractions ▪ Students learn how to work with percentages ▪ Students learn how to compare fractions ▪ Students learn how to convert fractions to decimal numbers ▪ Students learn how to multiply a natural number with a fraction ▪ Students learn the methodology of long division **Measurements** ▪ Students learn how measure volume ▪ Students learn conversions between the different units ▪ Students learn how to calculate the area and perimeter of rectangular, square and triangles with the use of formulas ▪ Students learn how the different monetary units relate to each other	Mathematics (Grade 5)

▪ Students learn how to measure angles using the right tools **Geometry** ▪ Students learn about the different types of lines ▪ Students learn how to construct triangles and parallelograms with the use of appropriate instruments ▪ Students learn the basic properties of pyramids and prisms **Algebra** ▪ Students learn how to investigate the relations among different patterns ▪ Students learn how to describe patterns ▪ Students learn about transitive property and how to use it in addition and multiplication ▪ Students learn how to solve equations **Statistics** ▪ Students learn to create graphs ▪ Students learn about the minimum, maximum and average value ▪ Students learn how to calculate probabilities	
Numbers and calculations ▪ Students learn to recognize, read, write, compare, order numbers till 1 billion ▪ Students learn the concept of negative numbers ▪ Students learn to work and solve problems with percentages ▪ Students deepen their understanding on long division ▪ Students learn how to work with percentages ▪ Students learn how to divide and multiply fractions ▪ Students learn the concept of analogy ▪ Students learn the concept of numerical powers and the power of 10 how to graphically represent analogy **Measurements** ▪ Students learn how to use the appropriate measurement unit ▪ Students learn how to calculate the area of a parallelogram ▪ Students learn how to calculate the external area of three dimensional objects ▪ Students learn about the summary of polygon angles **Geometry** ▪ Students learn about triangle's secondary elements i.e. median, altitude ▪ Students learn about circle's properties ▪ Students learn to construct the various angles ▪ Students learn for to recognise, classify and construct two dimensional shapes ▪ Students learn for to recognise, classify and construct three dimensional shapes in relation to the axes. **Algebra** ▪ Students learn how express powers ▪ Students learn how to simplify mathematical expressions ▪ Students learn how to solve equations ▪ Students learn about the priorities in performing the various calculations **Statistics** ▪ Students learn to create circular, bar, column and line charts ▪ Students how to calculate the average ▪ Students learn how to calculate probabilities	Mathematics (Grade 6)

9.1.2.2 Science

Topic	Subject
Waste ▪ Students learn about basic concepts related to waste and its management (i.e. waste; recycling, sustainability etc.) ▪ Air and environmental pollution ▪ Waste recycling within school ▪ Human activities that create waste ▪ Overconsumption of good and resources **Urban development** ▪ Understanding of basic environmental concepts ▪ Environmental elements (i.e. natural and manufactured elements, humans, animals) ▪ Urban and suburban lifestyles **Biodiversity** ▪ Flora at school, neighborhood, country ▪ Characteristics of country's flora and fauna ▪ Nutritional chains ▪ Human activities and how they affect a country's biodiversity **Forest** ▪ Basic concepts related to forests (i.e. air, soil, branches, stem, roots, leaves, flora, fauna etc.) ▪ Tree parts ▪ Cyprus flora ▪ Dangers for forest and prevention ▪ Forest fauna ▪ Consequences of forest destruction **Energy** ▪ Basic types of energy ▪ Energy and the human body ▪ Everyday habits and energy consumption at school and home ▪ Energy saving at school and home ▪ Solar energy as an alternative source of energy **Water** ▪ Basic concepts related to water (i.e. drought, rainfall, soil, humidity, ice, snow, sea, water cycle, lake, icebergs, ocean) ▪ Role of water in human body ▪ Water shortage and its causes ▪ Waste of water ▪ Ways of saving water at school and home	Science (Grades 1 and 2)
Waste ▪ Students learn about basic concepts related to waste and its management (i.e. waste; waste sorting, composting) ▪ Waste collection and management ▪ Reduction, reuse and recycling of materials ▪ Soil and water pollution ▪ Environment-friendly packaging ▪ Consumers' behaviour and waste creation	

Urban development ▪ Factors determining quality of life in the cities ▪ Modern ways of urban organisation ▪ Modern buildings and comparison to older developments ▪ Natural environment and urban development ▪ Water supply system ▪ Traffic, accessibility and parking issues ▪ Alternative means of transportation **Biodiversity** ▪ Levels of biodiversity ▪ Interactions among different organisms and their environment ▪ Basic characteristics of Cypriot biodiversity ▪ Rare and endangered plants and animals in Cyprus ▪ Factors threatening biodiversity in Cyprus **Forest** ▪ Forests of Cyprus now and then ▪ Cypriot flora, fauna and endangered species ▪ Century-old trees ▪ Forests as natural resources ▪ Forest fires and how they can be prevented **Energy** ▪ Types of energy ▪ Energy and natural resources ▪ Alternative sources of energy ▪ Production of electricity ▪ Consequences of energy overconsumption ▪ Renewable energy ▪ Everyday activities and energy consumption ▪ Measures that can reduce energy consumption **Water** ▪ Water transportations for domestic use now and then ▪ Consequences of water deficiency ▪ Quality of water ▪ Water pollution and its consequences	
Waste ▪ Management of solid and other types of waste ▪ Energy saving techniques ▪ Maintenance of natural resources ▪ European and national legislation related to waste ▪ Organic waste ▪ Public bodies, organisations and non-profit dealing with waste management **Urban development** ▪ Changes in cities' micro-climate ▪ Prototypes of urban living ▪ European and national legislation on maintaining the quality of living in cities ▪ "Green roofs" approach ▪ Buildings with indoor and outdoor pollution problems ▪ Building characteristics that guarantee its environmental friendliness **Biodiversity**	Science (Grades 5-6)

▪ National parks and protected areas ▪ "Natura 2000" network ▪ Changes in biodiversity, introduction of new species, extinction of species ▪ Use of recognition classification systems related to biodiversity ▪ Classification of species and organisms **Forest** ▪ Introduction to Natura 2000 network ▪ National parks in Cyprus and abroad ▪ Forest and human health ▪ Types of forests ▪ Morphology of Mediterranean forests **Energy** ▪ Energy production and how it impacts the environment ▪ Use of renewable sources of energy ▪ Use of nuclear energy ▪ Green energy ▪ Use of biomass ▪ Photovoltaic and wind power ▪ Low-energy buildings ▪ Advantages of bioclimatic architecture **Water** ▪ Water as non-renewable natural resource ▪ Climate zones ▪ Greenhouse effect ▪ Consequences of lakes, rivers, sea pollution	

9.1.2.3 Technology

The curriculum here is organised around the four following thematic areas:

a. Design
b. Construction
c. Assessment
d. Technological knowledge

Progress in each the above thematic areas is analysed based on four different scales starting from primary and going up to secondary education.

- Scale 1 covers grades 1,2,3,4
- Scale 2 covers grades 4, 5 and 6
- Scale 3 covers grades 6 till 3rd year of high school
- Scale 4 covers 3rd year of high school, 1st-2nd-3rd Lyceum

Topic	Subject
Technological knowledge ▪ Materials ▪ Communication – design ▪ Energy ▪ Technical control systems ▪ Electricity-Electronics ▪ Mechanics ▪ Construction systems	Technology (Grades 1 and 2)

▪ Design ▪ Construction ▪ Assessment ▪ Technological knowledge	
▪ Materials ▪ Communication – design ▪ Energy ▪ Technical control systems ▪ Electricity-Electronics ▪ Mechanics ▪ Construction systems ▪ Construction ▪ Assessment ▪ Technological knowledge	Technology (Grades 3)
▪ Communication ▪ Copyright ▪ Research and entrepreneurship ▪ Technical control systems ▪ Electronically digital systems ▪ Materials resistance ▪ Ergonomy ▪ Electric machinery ▪ Operational amplifier ▪ Design ▪ Construction ▪ Assessment ▪ Technological knowledge	Technology (Grades 4)

9.1.3 Estonia

Topics	Subject
Learn to make simple observations in nature and carry out simple investigatory activities	Cross-curricula
Learn to formulate experiences acquired, with the help of their senses, associated with phenomena and objects	Physics
Learn to undertake practical work using simple tools, following instructions and safety needs	Cross-curricula
Learn to formulate information gained from observations, draw conclusions and present them both orally and in written formats;	Cross-curricula
Learn to express science concepts in appropriate ways through both oral and written formats	Cross-curricula
Learn to apply science knowledge and skills gained from the study of science in undertaken decisions and appreciating the decisions of others in everyday life.	Cross-curricula
Learn to make weather observations, record and describe the weather and choose appropriate clothes when going outside	Physics
Learn to describe natural and artificial objects and phenomena on the basis of information acquired through the different senses	Physics
Learn to spot changes in nature which can be associated with the changing of seasons	Biology
Learn to identify forms of life of different organisms and the connections between them during different seasons	Biology
Learn to relate important seasonal changes that take place in nature to the life of humans	Biology

Learn to be familiar with, and express through a variety of means, features of the most common species of plants and animals in their living environment	Biology
Learn to observe how others relate with nature in positive and negative ways and their appreciation of the need to co-exist with nature	Biology

9.1.4 Germany

9.1.4.1 Mathematics[19]

Topic	Subject
Numbers and Operations - Understanding Numbers ▪ Illustrate the number range up to 1,000,000 using the decimal system ▪ Analyze and describe structural relationships between different number systems based on examples ▪ Use structures in number systems to understand numbers in extended number ranges ▪ Work in the number range up to 1,000,000 by counting in steps, as well as by arranging and comparing numbers according to various characteristics ▪ Discover relationships between individual numbers and in complex number systems, and describe these using mathematical terminology and symbols.	Mathematics (Grades 1 to 4)
Understanding Operations ▪ Match basic situations (which require adding and combining or taking away and separating) to the respective basic mathematical operations such as addition, subtraction, or completion ▪ Match basic situations (which require repeated addition of the same numbers or repeated subtraction of the same numbers) to the respective mathematical operations, such as multiplication or division (distribution) ▪ Switch between different representations of operations (e.g., material, symbolic, figurative, or language-based representations) ▪ Discover and describe characteristics of operations and laws of arithmetic based on examples ▪ Use mathematical terminology and symbols correctly.	Mathematics (Grades 1 to 4)
Fast Mental Arithmetic ▪ Have sound knowledge and skills of quick mental arithmetic in the number range up to 1,000,000 ▪ Repeat all multiplication tables (up to 10) automatically and be fluent in the inverses.	Mathematics (Grades 1 to 4)
Arithmetic ▪ Solve problems using all four basic operations (orally or in a partly standardized written form) by making use of arithmetical laws and analyze strategies using relationships between numbers and arithmetic laws (e.g., distributive law and commutative law of addition) in all four operations ▪ Solve problems using multiplication table relationships ▪ Describe and evaluate different arithmetic operations based on aspects of arithmetic and demonstrate clear understanding of these structures in writing.	Mathematics (Grades 1 to 4)
Numerals ▪ Explain in writing operations such as addition (with several addends), subtraction (with one subtrahend), multiplication (with multiple digits), and	Mathematics (Grades 1 to 4)

[19] This is an example of an overview of one science topic and curriculum focus at the primary school level in North Rhine-Westphalia (up to grade 4).

division (using remainder notations with single-digit and important double-digit divisors), describing the steps of calculation logically using examples ▪ Calculate fluently, confidently, and in written form using addition, subtraction, and multiplication.	
Estimations ▪ State approximate results of problems using numbers up to 1,000,000, and round and estimate to the appropriate accuracy.	Mathematics (Grades 1 to 4)
Flexible Calculating ▪ Calculate using individually preferred methods or standard methods, with and without a calculator.	Mathematics (Grades 1 to 4)
Dimension and Form ▪ Trace lines with a pen (eye-hand coordination), name overlapping figures (figure-ground discrimination), and identify forms (visual consistency) ▪ Orientation in two-dimensional space using a map. ▪ Describe spatial relations on the basis of pictures, arrangements, plans, etc., as well as from imagination. ▪ Visualize the movement of shapes and objects and describe the results of movement in advance.	Mathematics (Grades 1 to 4)
Spatial Orientation and Spatial Visualization ▪ Explore, name, and describe shapes using mathematical terminology (e.g., perpendicular, horizontal, parallel, square) ▪ Construct shapes by replacing, overlaying, or spreading elements, filling in spaces, and constructing, deconstructing, or continuing patterns ▪ Continue, describe, and construct patterns (e.g., band ornaments, tessellations) ▪ Name and compare areas of shapes and their perimeters ▪ Construct similar shapes from card paper by enlarging or reducing according to scale.	Mathematics (Grades 1 to 4)
Shapes ▪ Identify geometrical objects, sort them according to geometrical characteristics, and describe them using mathematical terminology (e.g., area, edge) ▪ Construct wireframe and solid models of objects and build more complex cube constructions ▪ Find various nets for cubes ▪ Identify two- or three-dimensional views of buildings and construct buildings according to a plan ▪ Define and compare volumes of objects with unit cubes.	thematics (Grades 1 4)
Solid Figures ▪ Examine shapes for axial (line) symmetry and use their characteristic length preservation and space preservation to explain the symmetry ▪ Construct symmetrical figures and use characteristics of axial (line) symmetry (length preservation and space preservation).	Mathematics (Grades 1 to 4)
Symmetry ▪ Construct line segments, simple figures, patterns, curves, and exact parallel or perpendicular lines using instruments like compasses and set squares, and use grid or point patterns to draw shapes and three-dimensional buildings.	Mathematics (Grades 1 to 4)
Drawing ▪ Measure quantities (length, time, weight, and volume) using suitable drawing instruments ▪ Compare and organize quantities	Mathematics (Grades 1 to 4)

▪ Name quantities of familiar objects and use these quantities as a reference for estimations ▪ Read time from analog and digital clocks ▪ Use monetary units (c, €) and units of length (mm, km), time (seconds, minutes, hours), weight (g, kg, t), and volume (ml, l), and convert between units ▪ Convert fractional quantities that occur in daily life into the next smaller unit (e.g., 14 l = 250 ml) ▪ Calculate with quantities (also using decimals).	
Measuring and Quantities ▪ Formulate arithmetical questions for real or simulated situations (also in project-oriented problem contexts) and for contextual problems, and solve them ▪ Use aids like tables, drawings, and diagrams to solve problems ▪ Reason that estimated values (estimation, evaluation) are sufficient and explain why an exact result is necessary or unnecessary ▪ Construct contextual problems (orally and in writing) for mathematical models (equations, tables, etc.).	Mathematics (Grades 1 to 4)
Perception and Handling of Quantities ▪ Collect data from real life situations and present it in diagrams and tables ▪ Extract data from calendars, diagrams, and tables to solve problems with arithmetic content.	Mathematics (Grades 1 to 4)
Factual Situations ▪ Describe the probability of simple events (using terms such as: certain, possible, impossible, always, often, rarely, never) ▪ Name the number of different possibilities in simple combination tasks.	Mathematics (Grades 1 to 4)
Data, Frequency, and Plausibility Collect data from real life situations and present it in diagrams and tables Extract data from calendars, diagrams, and tables to solve problems with arithmetic content	Mathematics (Grades 1 to 4)
Probability ▪ Describe the probability of simple events (using terms such as: certain, possible, impossible, always, often, rarely, never) ▪ Name the number of different possibilities in simple combination tasks	Mathematics (Grades 1 to 4)

9.1.4.2 Science [20]

Topic	Subject
▪ Materials and Their Transformation : Collect animate and inanimate materials from nature and organize them according to specific criteria ▪ Examine characteristics of materials and describe similarities and differences ▪ Examine visible material changes of animate and inanimate natural objects, present results, and describe them (i.e., states of matter such as water; dehydration processes of fruits; dissolution abilities of solids materials; and chemical transformations through combustion).	Nature and Life (Up to grade 4)
▪ Heat, Light, Fire, Water, Air, and Sound: Discover characteristics of heat, light, fire, water, air, and sound through experimentation. ▪ Observe and describe the importance of water, heat, and light for humans, animals, and plants. ▪ Plan an experiment and evaluate results.	Nature and Life (Up to grade 4)

[20] This is an overview of one science topic and curriculum focus at the primary school level in North Rhine-Westphalia (up to grade 4).

▪ Describe changes in nature and demonstrate stages of change (e.g., the water cycle and the seasons).	
▪ Magnetism and Electricity : Examine and describe the effect of magnets on various materials ▪ Construct simple electric circuits, and describe, explain, and follow safety rules when using electricity.	Nature and Life (Up to grade 4)
▪ Human Body, Senses, Nutrition, and Health: Examine and describe the meaning of the five senses in daily life. ▪ Identify and describe the functions of individual sensory organs. ▪ Identify and describe different nutrition habits and their effects. ▪ Describe the structures and basic functions of the human body (blood circulation, respiration, digestion). ▪ Describe hygiene basics, healthy nutrition, and healthy lifestyle. ▪ Formulate rules and advice for living a healthy lifestyle.	Nature and Life (Up to grade 4)
▪ Animals and Plants, and Their Habitats: Identify body structures and living conditions of animals and document the results. ▪ Observe and identify plants and their typical characteristics, and describe their habitat. ▪ Describe the development of animals and plants. ▪ Describe the relationship between habitats and living conditions for animals, humans, and plants.	Nature and Life (Up to grade 4)

9.1.5 Greece

9.1.5.1 Mathematics

Topic	Subject
Problem solving ▪ Students are expected to learn how to read problems, identify given information, rephrase the problem and use the provided info in order to arrive in a solution. **Numbers and calculations** ▪ Students are expected to learn how to read, write, order numbers till 100 ▪ Students learn how to add and subtract numbers till 20 ▪ Students learn how to divide a quantity into equal parts. **Measurements** ▪ Students are introduced to the concepts of: length, time, money & value, mass ▪ Students learn how to recognise, describe and extend geometrical motifs. **Geometry** ▪ Students learn about orientation ▪ Students learn how to identify three dimensional shapes: cylinder, sphere, cube ▪ Students are introduced to the concept of symmetry	Mathematics (Grade 1)
Problem solving ▪ Students are expected to learn how to read problems, identify given information, rephrase the problem and use the provided info in order to arrive in a solution. **Numbers and calculations** ▪ Students are expected to learn how to read, write, order numbers till 1000 ▪ Students practice in adding and subtracting numbers till 100 ▪ Students learn how to use the transitive property to addition and multiplication ▪ Students learn the concept of division. **Measurements** ▪ Students learn how to measure length using the correct ▪ Students practice the measurement of time, money and mass ▪ Students learn how to recognise, describe and extend numerical and geometrical motifs. **Geometry** ▪ Students practice on designing, reproduce and recognise the different shapes and their properties ▪ Students learn how to draw different types of lines ▪ Students learn how to recognise the basic three dimensional shapes ▪ Students learn how to complete the symmetry of a shape.	Mathematics (Grade 2)
Problem solving ▪ Students are expected to learn how to read problems, identify given information, rephrase the problem and use the provided info in order to arrive in a solution **Numbers and calculations** ▪ Students are expected to learn how to read, write, order numbers till 10000 ▪ Students practice in adding and subtracting numbers till 1000	Mathematics (Grade 3)

▪ Students are introduced to fractions and decimal numbers ▪ Students learn how to multiply and divide natural numbers **Measurements** ▪ Students learn how to measure length using the correct units ▪ Students learn how to recognise motifs and prove that they continue indefinitely **Geometry** ▪ Students practice on designing, reproduce and recognise the different shapes and their properties ▪ Students learn the concepts of facet, right angle, vortex, edge ▪ Students learn how to complete the symmetry of a shape	
Problem solving ▪ Students are expected to learn how to read problems, identify given information, rephrase the problem and use the provided info in order to arrive in a solution. **Numbers and calculations** ▪ Students are expected to learn how to read, write, order numbers till 100000 ▪ Students practice in adding, subtracting; multiplying and dividing natural numbers till 1000 ▪ Students practice in carrying out calculations with fractions and decimal numbers. **Measurements** ▪ Students practice is measuring length, area, time, money, mass and volume ▪ Students practice conversion between different units ▪ Students learn how to identify simple numerical and geometrical motifs. **Geometry** ▪ Students practice on how to draw parallel and vertical lines by using the appropriate instruments ▪ Students learn how to calculate the perimeter of different shapes ▪ Students practice the design on three dimensional shapes using the appropriate methodology. **Data collection and interpretation** ▪ Students learn how to collect, classify, represent and interpret data ▪ Students are introduced to the concept of probabilities.	Mathematics (Grade 4)
Problem-solving ▪ Students are expected to learn how to read problems, identify given information, rephrase the problem and use the provided info in order to arrive in a solution. **Numbers and calculations** ▪ Students are expected to learn how to read, write, order numbers till 100 000 000 ▪ Students learn how to add; subtract, multiply and divide natural numbers, fractions and decimal numbers ▪ Students learn the multiplication and division tables of 2,3,4,5...10. **Measurements** ▪ Students are practising their knowledge on the various measurement units and learn how to use them in their day to day lives	Mathematics (Grade 5)

▪ Students practice the recognition and description of simple numerical and geometrical motifs. **Geometry** ▪ Students practice on how to draw various shapes by using the appropriate instruments ▪ Students learn how to calculate the perimeter and area of basic shapes ▪ Students learn to recognise and name the various types of angles. **Data collection and interpretation** ▪ Students learn how to create charts and how to interpret them ▪ Students are introduced to the concept of probabilities ▪ Students learn how to compose hypothesis and how to calculate the average.	
Problem-solving ▪ Students are expected to learn how to read problems, identify given information, rephrase the problem and use the provided info in order to arrive in a solution. **Numbers and calculations** ▪ Students are expected to know how to read, write and order all natural, fractional and decimal numbers plus carry out all possible calculations ▪ Students learn which numbers are divided by 2,3,4,5,9, 10 and 25 **Measurements** ▪ Students are reminded how to use the various measurement units and how to use them in day to day life ▪ Students learn how to compose a rule for a simple numerical and geometrical motif. **Geometry** ▪ Students are reminded how to use the various measurement units and how to use them in day to day life ▪ Students practice on how to draw a line or a circle with the use of ruler and a calliper ▪ Students learn how to calculate the perimeter and area of a cycle plus the areas and volumes of three dimensional objects ▪ Students learn how to reproduce, draw and compare different angles ▪ Students learn how to scale images up or down **Data collection and interpretation** ▪ Students learn how to create and interpret different types of charts ▪ Students work more on the meaning and how to calculate averages ▪ Students learn how to compose hypothesis and how to calculate the average ▪ Students learn how to solve equations.	Mathematics (Grade 6)

9.1.5.2 Science

Topic	Subject
My classroom ▪ Students are introduced to the concept of social groups and observe the needs that a class fulfils **My school** ▪ Students are encouraged to develop the spirit of collaboration ▪ Students are encouraged to understand the need of following certain rules in order to respond to special situation i.e. emergencies, earthquake etc. **My family** ▪ Students are looking into the importance of family and its different roles its members can have ▪ Students understand how love, understanding and collaboration are important and ensure that a family functions properly **Hums and time** ▪ Students learn how time is measured and they get familiar with the use of vocabulary and expressions around this **My neighbourhood** ▪ Students gain an understanding of their surrounding and the problems neighbourhood's face **Objects from my environment** ▪ Students learn how to identify solid, liquid and gas objects **The role of energy in our lives** ▪ Students learn about the use of electricity and energy saving techniques **How humans affect their environment** ▪ Students learn how human behaviour affects our surroundings **Introduction to the human body** ▪ Students learn about the basic characteristics of the human body ▪ Students learn about health habits and how they can promote good health ▪ Students learn about disabilities **Humans' needs** ▪ Students learn about humans' basic needs and how they are satisfied ▪ Students learn about professions related to the above mentioned needs **Communication, information and leisure time** ▪ Students learn about the main means of communication ▪ Students are invited to think about how much time they spent watching TV and they are encouraged to evaluate the programs they watch **How sounds travels** ▪ Students are introduced to the concept of sound and its main characteristics **Natural environment and animals** ▪ Students learn how to recognize the animals and plants in their environment	Science (Grade 1)

▪ Students learn about the relation between the environment and our quality of life **Sun, day and night** ▪ Students learn about the relation between sun's position in the sky and the rotation from day to night	
My school ▪ Students learn how to orientate themselves in the school environment ▪ Students learn about how they affect their school environment ▪ Students are made aware of how to treat classmates with special needs **My neighbourhood/ my village** ▪ Students learn about the various services that are available for them in their area ▪ Students learn about the environmental problems in their area **Plants and animals in my area** ▪ Students learn about the factors affecting the development of plants and animals in their area **Circle of water** ▪ Students learn how to relate the different weather conditions with the different seasons and a place's geographical position **Human-environment interaction** ▪ Students learn about how the environment impacts our quality of life ▪ Students learn about orientation ▪ Students learn about the importance of public transportation ▪ Students learn about energy, its use and its importance	Science (Grade 2)
Human environment ▪ Students learn about the reasons driving humans to live in communities ▪ Students learn to appreciate the usefulness of having rules within the communities ▪ Students learn about the decision making processes within a community **Human-environment interaction** ▪ Students learn about how humans activities affect the environment ▪ Students get familiar with the use of different geographical terms ▪ Students learn about health and its relation to nutrition ▪ Students learn about different types of communications ▪ Students learn to be critical when it comes to news and newspapers, magazines etc. ▪ Students learn about consumption and how to assess different products usefulness and nutritional value ▪ Students learn to differentiate between individual and group sports	Science (Grade 3)
Human-environment interaction ▪ Students learn to recognise that their city/village is part of province ▪ Students learn about the different provinces of Greece ▪ Students learn about the major cities of Greece and how cities, seas, mountains are represented on the map ▪ Students learn how to classify animals based on their characteristics ▪ Students learn about environmental challenges in their area ▪ Students are encouraged to propose solutions that will contribute to the improvement of their living conditions ▪ Students learn about the various occupations available in their area and how they contribute to the local economy	Science (Grade 4)

▪ Students develop their critical skills when it comes to media reports ▪ Students are encouraged to compare Greece's culture to other countries and identify its distinct elements ▪ Students investigate the differences between sport and championship ▪ Students look into how muscles and bones work in order to support human body ▪ Students look into the light, temperature, air and their properties	
▪ Students learn that all objects have some common basic characteristics (mass, volume, density) ▪ Students learn about molecules and how they affect different objects' characteristics ▪ Students learn to describe electricity related phenomena by using molecules ▪ Students learn to recognise motion as a basic characteristic of materials ▪ Students learn to describe motion ▪ Students learn how to define forces and how they are applied ▪ Students learn to connect the different conversions that occur in nature with energy ▪ Students learn that energy is never lost but it's always saved ▪ Students learn to appreciate energy saving ▪ Students learn about acids and their properties	▪ Physics/chemistry (Grade 5)
▪ Students learn about energy and its different forms ▪ Students learn how energy is never lost and how it changes forms and it is stored ▪ Students learn about current energy sources and the need for their conscious use ▪ Students learn about alternative energy sources ▪ Students learn about the relation between electricity and magnetism ▪ Students learn about ardency, how it is transmitted and how its properties relate to everyday life	Physics/chemistry (Grade 6)

9.1.5.3 Geography

Topic	Subject
▪ Students learn to use of compass for orientation purposes ▪ Students learn to identify the symbols used in maps to differentiate mountains, lakes, sea etc. ▪ Student learn vocabulary related to morphology i.e. mountain; hill etc. ▪ Students learn about how human behaviour and activities affect the environment and the organisation of cities/towns/villages	Geography (Grade 3)
▪ Students learn to demonstrate on the map the location of different towns and provinces ▪ Students learn more about maps and how they represent reality based on aerial photos ▪ Students learn about the flora and fauna in different parts of Greece ▪ Students learn about the different seasons and how they affect human activities ▪ Students learn about the different occupations and how they relate to the way of life of each place	Geography (Grade 4)

9.1.6 Portugal

9.1.6.1 Science

First Cycle

Topic	Subject
Discovering Myself (Grade 1) Concepts related to their own bodies, basic health, and well-being. Topics taught include the recognition and identification of physical characteristics of the	Science (Grades 1 to 4)

body, sexual identity, parts of the body, and their comparison with other children, parents, brothers, and sisters. In the second grade, the study of the body focuses on sensory organs, body development (e.g., the loss of milk teeth), basic health and hygiene, and well-being (e.g., recognizing the importance of vaccines) **Discovering Myself (Grade 3)** Vital organs and their functions (e.g., digestion, blood circulation, and respiration), physical sensations, and mental states are introduced. Finally, in Grade 4, the study of the body progresses to the study of bones and skeletal structure and its functions, the study of the muscular system and its functions, and the study of the skin and its functions **Discovering Myself (Grade 4)** Discovering the Natural Environment: students are taught lessons related to the basic elements of the physical environment (air, water, rocks, and soil), the organisms inhabiting the environment, the climate, geology, and basic astronomy **Discovering the Natural Environment (Grade 1)** How to cultivate plants and care for animals in the classroom or school facilities, and observe plants and animals in different life stages. They are taught to observe and register the weather in elementary ways, compare the duration of day and night throughout the year, and recognize the different forms in which water can exist in nature. **Discovering the Natural Environment (Grade 2)** Students focus on the identification of common plants in the near environment, including spontaneous and cultivated plants and crops, recognize and identify the different plant parts (roots, stems, leaves, flowers, fruits) and observe plant development across the year. Students observe and record weather, recognize different weather conditions and relate them to the different seasons, and recognize the existence of air and its movement. **Discovering the Natural Environment (Grade 3)** Students learn to compare and classify plants according to some criteria (e.g., type and color of flowers, leaf and root shapes, edible and inedible plants). They perform basic experiments with plant reproduction by seeds and cuttings. They learn to compare and classify animals according to their appearance and mode of living. They learn some effects of environmental conditions on the life of plants and animals (e.g., water, light, and temperature) and learn about simple food chains. Students learn to collect soil and rock samples and do simple characterizations of soil and rocks, and distinguish land forms in the region (e.g., elevations, valleys, and plains) and water environments. In this grade, students are introduced to basic astronomy, recognizing the sun as a source of light and heat and observing its positions during the day (i.e., sunrise, midday, and sunset). **Discovering the Natural Environment (Grade 4)** Students recognize and observe physical phenomena including water condensation (fog and dew), solidification, and precipitation (i.e., rain, snow, and hail). The teaching of these subjects involves simple experiments with evaporation, condensation, and solidification. Students further study the water cycle and how groundwater and water springs develop. In astronomy, students learn about Earth's shape, the moon's phases, and the locations of Earth and the moon in the solar system **Discovering Materials and Objects (Grade 1)** Students explore different physical and chemical properties of common daily use materials. Although the experimental approach also is present in the other science blocks, this block is more focused on experimentation with materials with all its implications: observation, including modification of experimental conditions; study and interpretation of results; and developing conclusion.	

Discovering Materials and Objects (Grade 2) Students study and experiment with daily materials (e.g., sugar, salt, wood, and clay) and classify materials according to their characteristics. They do simple experiments with water: capacity and volume, physical properties, recognition of floating materials, and observing water's effects on different materials. Identification and production of sounds also is introduced at this grade. **Discovering Materials and Objects (Grade 3)** Students further expand their simple experiments and observations with common daily materials, studying their properties (e.g., flexibility, resistance, solubility, and transparency). They do simple experiments with air (e.g., balloons and syringes) and recognize properties of air (e.g., weight and temperature) and air's effects on different objects. Students do simple experiments with light (e.g., identify sources of light, and observe interactions of light with different materials, such as transmission, absorption, and reflection) and magnets (e.g., observe the behaviour of different materials in the presence of magnets, magnetize different objects, and build a compass). They also study basic mechanics and observe the results of simple experiments with levers, pulleys, springs, and elastic materials. Discovering Relations between Nature and Society at the improvement of the natural environment, the rational use of natural resources, and the development of an informed and active participation in solving environmental problems **Discovering Relations between Nature and Society (Grade 3)** Students study the impact of agriculture, livestock farming, forest exploration, and fishing activities in the local economies and environment **Discovering Relations between Nature and Society (Grade 4)** They study environment quality, identify elements that promote or deteriorate the environment quality, and identify sources of pollution and environmental imbalances due to human activities.	

Second cycle

Topic	Subject
▪ Students learn about the importance of the physical elements (i.e., water, air, rocks, and soil) for all living organisms ▪ Students learn about the diversity of living organisms (plants and animals) and their interactions with the environment ▪ Students learn about cells as the basic unit of life ▪ Students learn about the hierarchical organization of living organisms ▪ Students learn about vital processes common to all living organisms, including nutrition exchanges between animals, plants, and the environment ▪ Students learn about human and plant reproduction ▪ Students learn about microorganisms and their relation to hygiene and social problems	Science

Third cycle

Topic	Subject
Space—The universe, the solar system, distances in the universe, Earth, the moon, and gravitational forces Materials—Substances and mixtures, physical and chemical transformations, physical and chemical properties of materials, and separation of substances in a mixture Energy sources and energy transfer.	Science (Grade 7)

Chemical reactions—Representation and understanding of chemical reactions, types, and reaction rates Sound—Production and propagation, sound as waves, sound attributes and their detection by humans, and acoustic phenomena Light—Light waves, their propagation, and optical phenomena	Science (Grade 8)
Movement and forces—Movement on Earth, forces, movement and energy, and liquids Electricity—Electric currents, and energy and its effects Materials classification—Atomic structures, properties of elements of the Periodic Table, and chemical bonding	Science (Grade 9)

9.1.6.2 Mathematics

First cycle

Topic	Subject
Numbers and operations ▪ Understand the notion of natural numbers, use numerical relations and the decimal system, represent numbers, read and write numbers to at least 1,000, decompose numbers and solve problems using numerical relations ▪ Learn the concepts underlying the four arithmetic operations (addition, subtraction, multiplication, and division), and use these operations to solve real life problems ▪ Construct and investigate patterns in number sequences ▪ Develop a basic understanding of non-negative rational numbers as fractions (identify and represent fractions).	Mathematics (Grades 1 and 2)
Numbers and operations ▪ Develop an understanding of and use numerical relations, recognize multiples and factors of numbers, and read and write numbers up to 1 million ▪ Develop strategies for mental calculations for the four basic operations using their properties, and develop and understand methods and algorithms for basic calculations (multiplication and division by 10, 100, 1,000, etc.) ▪ Further develop pattern recognition in number sequences and develop skills to solve problems with proportionalities ▪ Deepen understanding of non-negative rational number as fractions, and develop skills to work with fractions and decimal numbers.	Mathematics (Grades 3 and 4)
Geometry and Measurement Develop spatial orientation with emphasis on the visualization and understanding of the properties of geometric figures, including position and location relative to other objects Understand the notion of measurement, its process, and the different magnitudes of quantities involving money, length, area, mass, capacity, volume, and time	Mathematics (Grades 1 and 2)
Geometry and Measurement Further, develop the ability to visualize geometric figures and their properties and operations in space, read maps, plants, and drawings, and locate objects in a coordinates system. Further, develop the capacity for measurement and use of mathematical operations with money, length, mass, capacity, area, volumes, and time, and their estimation and conversion.	Mathematics (Grades 3 and 4)
Organization and data processing	Mathematics (Grades 1 and 2)

Read and interpret data in tables and graphs, classify data using Venn and Carroll diagrams, and construct absolute frequency tables, graphs, and pictograms	
Organization and data processing Read and represent data, understand random events and their properties, construct data summaries in absolute and relative frequency data tables, construct and understand bar graphs, and identify the mode in a data set	Mathematics (Grades 3 and 4)

Second cycle

Topic	Subject
Numbers and operations ▪ Understand natural numbers, including prime and composite numbers and their decomposition, least common multiple and largest common divisor of two numbers, and powers of numbers and their operations ▪ Understand, represent in the numerical line, and do calculations with integers, non-negative rational numbers, representation and numerical operations, approximate values and percentages	Mathematics (Grades 5 and 6)
Geometry ▪ Geometric solids (prism, sphere, pyramid) and their models and plane representations ▪ Geometric figures in the plane, straight lines, semi-lines and line segments, angles' amplitude and measurement, polygons, circles and circumference's properties and construction ▪ Reflection, rotation, and translation, axial and rotational symmetries ▪ Area, perimeter, and volume.	
Algebra ▪ Develop algebraic reasoning and skills to represent mathematical and nonmathematical conditions with the use of mathematical symbols ▪ Relations and regularities, numerical expression and calculus properties, direct proportionality.	
Organization of Data and Data Processing ▪ Develop the skills to understand and produce statistical information, as well as to use statistical results and information to solve problems and make supported and informed decisions ▪ Data representations and interpretation, absolute and relative frequency tables, bar graphs, circular plots, line plots, and stem-and-leaf graphs ▪ Arithmetic mean, extreme values, and range	

Third cycle

Topic	Subject
Numbers and operations ▪ Further develop and understand the notion of integers and rational numbers and their properties and operations ▪ Powers, quadratics, and cubic roots ▪ Notion of real numbers and their rational and nonrational parts, their representation on the real number line; understand and do more complicated operations in the domain of real numbers; intervals of real numbers; solve problems and examine patterns using real numbers	Mathematics (Grades 7 to 9)
Geometry ▪ Understand, classify, and do operations with triangles and quadrilaterals; understand their properties and properties of angles; geometric solids areas and volumes; parallel and perpendicular lines; and planes, circumferences, and angles ▪ Understand and construct geometric planes, circles, circumferences, bisectors, spherical surfaces, and mediator planes ▪ Construct inscribed and circumscribed circles and polygons ▪ Identify and construct congruent and similar figures ▪ Recognize and use vectors in geometric transformations (translation, reflection, and rotation) ▪ Demonstrate and use the Pythagorean theorem ▪ Understand and use right angle trigonometry, trigonometric ratios and their relations, and second-order equations with one variable.	Mathematics (Grades 7 to 9)
Algebra ▪ Develop algebraic reasoning and language and solve problems involving algebraic procedures using sequences and patterns ▪ Understand and solve first-degree equations with one unknown, literal equations, and polynomials; understand and solve second-degree equations with one unknown and two equations systems with two unknowns; and understand and solve first-order inequalities ▪ Understand and solve first-degree equations with one unknown, literal equations, and polynomials; understand and solve second-degree equations with one unknown and two equations systems with two unknowns; and understand and solve first-order inequalities.	Mathematics (Grades 7 to 9)
Organization of Data and Data Processing ▪ Further develop the use of statistical data analysis to make informed decisions ▪ Develop skills for statistical planning, formulate questions and plan adequate data collection ▪ Further emphasis on the organization, analysis, and interpretation of data, construct and interpret graphical data representations, and understand the concepts and estimate measures of central tendency and dispersion ▪ Choose the appropriate statistics for different data types, compare data distributions, and discuss critically inferences to populations from the analysis of samples ▪ Understand the notion of random events and random experiments, and understand and do probability calculations using relative frequencies and the Laplace rule	Mathematics (Grades 7 to 9)

9.1.7 Finland

9.1.7.1 Physics

Topic	Subject
Scientific research: Suitable contents for accurately instructed and open-ended research are selected from different content areas as well from pupils' topics of interest. When conducting research, the relevant stages of the research process are emphasised, such as reflecting on a problem or a phenomenon, planning, setting up experiments, making observations and measuring, compiling and processing results, as well as evaluating and presenting results. The pupils are acquainted with utilising information and communication technology at different stages of research.	Physics
Physics in the pupil's daily life and living environment: Contents are selected to allow the pupils to consider phenomena of their own lives and living environment, particularly from the viewpoint of health and safety. When selecting contents, possibilities of the local environment are taken into account. The pupils familiarise themselves with forms of electromagnetic and particle radiation. They focus on some phenomena of heat on the qualitative level.	Physics
Physics in the society: Contents related to physical phenomena and technological applications are chosen, particularly from the viewpoint of the society and its development. The main emphasis is on energy production and sustainable use of energy resources. The pupils familiarise themselves with different educational paths and professions in which competence in physics is required.	Physics
Physics shaping the worldview: Contents are selected to express the nature of physics as a discipline, the law of conservation of energy and the structures and dimensions of the universe. The contents also include familiarisation with physics-related news, current topics, applications, and modern-day research.	Physics
Interaction and motion: The contents are related to different types of interaction and states of motion of objects. The instruction moves from interactions between two objects to forces affecting one object and the impact of these forces on the motion of the object. Motion is also described quantitatively using models for constant and changing motion. Mechanical work and power are connected to energy qualitatively.	Physics
Electricity: The connection between voltage and the electric current is used as the basis for the examination of the electric circuit. The circuit is first examined qualitatively on the level of phenomena and properties, and then quantitatively by measuring the values of quantities and by examining dependencies between the quantities. Contents related to electrical safety at home and the use and generation of electricity are selected. Electrical charge and magnetism are connected to the various phenomena of electric circuits qualitatively.	Physics

9.1.7.2 Chemistry

Topic	Subject
Scientific research: The principles of working safely and basic working skills lay a foundation for experimental working. Suitable contents for closed-ended and open-ended research are selected from different content areas as well from pupils' topics of interest. When conducting research, the relevant stages of the research process are emphasised, such as reflecting on a problem or a phenomenon, planning, setting up an experiment, making observations, compiling and processing results, as well as evaluating and presenting results. The pupils get acquainted with utilising information and communication technology at different stages of research.	Chemistry
Chemistry in the pupil's daily life and living environment: Contents are selected to allow the pupils to consider phenomena of their own lives and living environment, particularly from the viewpoint of health and safety. When selecting contents, the possibilities of the local environment and the state of the pupils' surroundings are taken into account. The pupils get acquainted with chemicals and fire safety at home. They examine changes in states of matter.	Chemistry
Chemistry in the society: Contents related to chemical phenomena and applications are chosen particularly from the viewpoint of technology and the well-being of the humankind. The main emphasis is on sustainable use of natural resources, and the idea of product life cycle is one of the used perspectives. The pupils familiarise themselves with different educational paths and professions in which competence in chemistry is required.	Chemistry
Chemistry shaping the worldview: Contents are selected to express the nature of chemistry as a discipline, the laws of conservation of mass and energy and the dimensions of nature. The contents include familiarisation with chemistry-related news, current topics, applications, and modern-day research.	Chemistry
Properties and structure of substances: The pupils examine the properties of mixtures and pure substances, such as water solubility and fat solubility. Based on the characteristics of chemical elements, the pupils familiarise themselves with the atomic structure of matter, the structure of an atom, and the periodic table. Models and simulations are used to help the pupils perceive the structure of chemical compounds. The pupils familiarise themselves with carbon and its compounds as well as nutrients. They get acquainted with some organic compound group.	Chemistry
Properties and changes in substances: The pupils familiarise themselves with the changes of energy and substances in chemical reactions. They make observations on reaction rate and consider factors that influence it. They get acquainted with the carbon cycle and its significance for life. They familiarise themselves with concentration and acidity in connection to everyday examples. They practise interpreting the language of chemical symbols and simple reaction equations.	Chemistry

9.1.8 France

9.1.8.1 Mathematics

Topic	Subject (indicative since most of these topics appear under the general topic of Science)
Numbers and calculations ▪ Students learn to count in the decimal number system up to 1,000. They enumerate collections to develop number sense, and they learn to sequence, compare, and order numbers. Students memorize and use addition and multiplication tables (by 2, 3, 4, and 5), learn the operations of addition, subtraction, and multiplication, and learn to solve problems using these operations. Exercises in grouping and sharing provides an introduction to learning division with numbers up to 100. Daily exercises in mental arithmetic allow students to develop a more thorough knowledge of numbers and their properties. **Geometry** ▪ Students develop their spatial sense in two and three dimensions. They learn to recognize and describe plane figures and solids. They use instruments and learn techniques for reproducing or tracing plane figures. They learn specific vocabulary. **Quantities and measures** ▪ Students learn and compare units of length (mm, cm, m, and km), mass (kg and g), capacity (litre), time (hour, half hour), and currency (euro, euro cent). They begin to solve problems involving length, mass, time, and currency. **Organization and Management of Data** ▪ Students gradually learn to use common representations of data (e.g., tables and graphs	Mathematics (Grades 1 and 2)
Natural whole numbers ▪ Principles of decimal place value ▪ Reading and writing numbers in figures and in words ▪ Comparing and ordering numbers, locating numbers on a graduated line, and using the signs > and < ▪ Arithmetic relationships between commonly used numbers (e.g., double, half, quadruple, quarter, triple, and third) and the concept of multiples. **Decimal numbers and fractions** ▪ Simple and decimal fractions—Writing fractions, locating fractions between two consecutive integers, writing fractions as the sum of an integer and a fraction less than 1, and calculating the sum of two decimal fractions or the sum of two fractions with the same denominator ▪ Decimal numbers—Reading and writing decimals, determining decimal place value, converting between decimals and fractions, comparing, ordering, and locating decimals on a number line, and rounding decimals to the nearest whole number, the nearest 10th, and the nearest 100th. **Calculation** ▪ Mental—Learning addition and multiplication tables; daily exercises in mental calculation using the four operations help students develop number sense ▪ Written—The mastery of an arithmetic technique for each of the four operations is essential	Numbers and calculation (Grades 3 to 5)

▪ Calculator—Students learn to use calculators depending on the computational complexity of the problems they are solving. **Geometry** ▪ Geometric relationships and geometric properties—Alignment, perpendicularity, parallelism, equality of lengths, axial symmetry, middle of a segment ▪ The use of instruments and techniques—Ruler, square, compass, tracing paper, graph paper, dotted paper, and folding paper ▪ Plane figures—Squares, rectangles, diamonds, parallelograms, triangles, special triangles, and circles ▪ Describing, reproducing, and constructing plane figures ▪ Learning vocabulary specific to plane figures (e.g., side, top, angle, diagonal, axis of symmetry, centre, radius, and diameter) ▪ Enlarging and reducing plane figures, linked with proportionality ▪ Regular solids (i.e., cubes, rectangular parallelepipeds, cylinders, prisms, and pyramids) ▪ Recognizing regular solids and studying certain patterns ▪ Learning vocabulary specific to regular solids (e.g., vertex, edge, and face) ▪ Reproducing and constructing various geometric configurations requires students to apply their knowledge of regular figures, gives students the opportunity to use specific vocabulary, and approaches to measuring and drawing. **Quantities and measures** ▪ Length, mass, and volume—Measurement, estimation, legal units of the metric system, calculation of quantities, converting between units of measurement, perimeter of a polygon, formulas for the perimeter of a square and of a rectangle, circumference of a circle, volume of a rectangular parallelepiped ▪ Area—Comparing surfaces according to their area, regular units, conversions; formulas for area of a rectangle and of a triangle ▪ Angles—Comparing angles, using templates and set squares; acute, obtuse, and right angles ▪ Time—Reading clocks and calendars; Duration—Units of measurement of duration, calculating time elapsed between two given moments. **Organization and management of data** ▪ Students gradually learn to sort data, to classify data, and to read, produce, and analyse tables and graphs. ▪ Proportionality is taught in contexts involving percent, scale, unit conversion, and enlargement or reduction of figures, and using several different procedures (especially the rule of three).	

9.1.8.2 Science

Topic	Subject
Space and time ▪ Students discover and begin to develop simple representations of familiar spaces (e.g., their classroom, school, neighbourhood, village, and town). They compare these familiar environments with other more distant environments and spaces. They discover common forms of representation (e.g., photographs, maps, world maps, planispheres, and globes). Students learn to identify the alternation of day and night, weeks, months, and seasons. They use tools for tracking and measuring time (i.e., calendars and clocks). They discover and memorize particular points of reference in time (i.e., certain dates and figures in the history of France); and they become aware of changing lifestyles. **Living Things, Matter, and Objects**	Science (Grades 1 to 3)

▪ Students identify the characteristics of living things (i.e., birth, growth, and reproduction), and nutrition and animal diets. They learn principles of hygiene and security, personal and collective. They understand the interactions between living things and their environment, and they learn to respect the environment. ▪ Students distinguish between solids and liquids and perceive changes in states of matter. They construct elementary models and simple electrical circuits to develop their understanding of how devices operate.	
The Sky and Earth ▪ The movement of Earth (and the other planets) around the sun, Earth's rotation, the length of day, and how it changes with the seasons ▪ The movement of the Moon around Earth ▪ Light and shadows ▪ Volcanos and earthquakes, and the risks they present to human societies. **Matter** ▪ Water—A resource; its states and changes of state; its path in nature; and maintaining its quality for different uses ▪ Air and air pollution ▪ Mixtures and solutions ▪ Waste—Reduce, reuse, recycle **Energy** ▪ Simple examples of energy sources (e.g., fossil and renewable) ▪ Energy needs, consumption, and savings ▪ Unity and diversity among living things ▪ Introduction to biodiversity—investigate differences among living species ▪ Introduction to the unity of living things—investigate similarities among living species ▪ Introduction to the classification of living things—similarities and differences of interpretation of kinship. **The functioning of living things** ▪ Stages of development of a living thing (plant or animal) ▪ Conditions of development of plants and animals ▪ Breeding patterns of living things ▪ The functioning of the human body and health ▪ Body movement (muscles, bones, and joints) ▪ Introduction to metabolic functions—digestion, breathing, and blood circulation ▪ Human reproduction and sex education ▪ Hygiene and health—beneficial or harmful behaviours, particularly in sports, diet, and sleep **Living things in their environment** ▪ The adaptation of living things to environmental conditions ▪ The place and role of living things in their environment; food chains and food webs ▪ The evolution of an environment managed by humans (e.g., forests) and the importance of biodiversity **Technical objects** ▪ Electrical circuits powered by batteries ▪ Safety rules and electricity hazards ▪ Levers, scales, and balances ▪ Mechanical objects and transmission of movement.	Science (Grades 3 to 5)

9.1.9 The Netherlands

Topic	Subject

▪ The pupils learn to distinguish and name many common plants and animals in their own environment and the way they function. ▪ The pupils learn about the makeup of plants, animals and humans and about the form and function of their parts. ▪ The pupils learn to research materials and physical phenomena, including light, sound, electricity, power, magnetism, and temperature. ▪ The pupils learn to describe the weather and climates in terms of temperature, precipitation, and wind. ▪ The pupils learn to design, realise and evaluate solutions for technical problems.	Nature/Biology
Mathematical insight and operation ▪ The pupils learn to use mathematical language (arithmetical, mathematical and geometrical terms, formal and informal notations, schematic representations, tables and graphs, and exercises for the calculator) ▪ The pupils learn to solve practical and formal arithmetical and mathematical problems and clearly represent argumentation ▪ The pupils learn to motivate approaches for solving arithmetical/mathematical problems and learn to assess solutions. **Numbers and calculations** ▪ The pupils learn to understand the general structure and interrelationship of quantities, whole numbers, decimal numbers, percentages, and proportions, and to use these to do arithmetic in practical situations. ▪ The pupils learn to quickly carry out the basic calculations in their heads using whole numbers, at least to 100, whereby adding and subtracting up to 20 and the multiplication tables are known by heart. ▪ The pupils learn to count and calculate by estimation. ▪ The pupils learn clever ways to add, subtract, multiply and divide. ▪ The pupils learn to add, subtract, multiply and divide on paper, according to more or less contracted standard procedures. ▪ The pupils learn to use the calculator with insight. **Measuring and geometry** ▪ The pupils learn to solve simple geometrical problems. ▪ The pupils learn to measure and calculate using units and measurements, such as time, money, length, circumference, surface area, volume, weight, speed, and temperature.	Mathematics

9.1.10 UK (England)

9.1.10.1 Mathematics

Topic	Subject
Number – number and place value ▪ count to and across 100, forwards and backwards, beginning with 0 or 1, or from any given number ▪ count, read and write numbers to 100 in numerals; count in multiples of twos, fives and tens ▪ given a number, identify one more and one less ▪ identify and represent numbers using objects and pictorial representations including the number line, and use the language of: equal to, more than, less than (fewer), most, least ▪ Read and write numbers from 1 to 20 in numerals and words. **Addition and subtraction** ▪ read, write and interpret mathematical statements involving addition (+), subtraction (–) and equals (=) signs ▪ represent and use number bonds and related subtraction facts within 20 ▪ add and subtract one-digit and two-digit numbers to 20, including zero	Mathematics (Year 1)

▪ Solve one-step problems that involve addition and subtraction, using concrete objects and pictorial representations, and missing number problems such as 7 = – 9. **Multiplication and division** ▪ Solve one-step problems involving multiplication and division, by calculating the answer using concrete objects, pictorial representations and arrays with the support of the teacher. ▪ recognise, find and name a half as one of two equal parts of an object, shape or quantity ▪ recognise, find and name a quarter as one of four equal parts of an object, shape or quantity. **Measurement** ▪ compare, describe and solve practical problems for: - lengths and heights [for example, long/short, longer/shorter, tall/short, double/half] - mass/weight [for example, heavy/light, heavier than, lighter than] - capacity and volume [for example, full/empty, more than, less than, half, half full, quarter] - time [for example, quicker, slower, earlier, later] ▪ measure and begin to record the following: - lengths and heights - mass/weight - capacity and volume - time (hours, minutes, seconds) ▪ recognise and know the value of different denominations of coins and notes ▪ sequence events in chronological order using language [for example, before and after, next, first, today, yesterday, tomorrow, morning, afternoon and evening] ▪ recognise and use language relating to dates, including days of the week, weeks, months and years ▪ tell the time to the hour and half past the hour and draw the hands on a clock face to show these times. **Geometry – properties of shapes** ▪ recognise and name common 2-D and 3-D shapes, including: ▪ 2-D shapes [for example, rectangles (including squares), circles and triangles] ▪ 3-D shapes [for example, cuboids (including cubes), pyramids and spheres]. **Geometry – position and direction** ▪ describe position, direction and movement, including whole, half, quarter and three-quarter turns.	
Number – number and place value ▪ count in steps of 2, 3, and 5 from 0, and in tens from any number, forward and backward ▪ recognise the place value of each digit in a two-digit number (tens, ones) ▪ identify, represent and estimate numbers using different representations, including the number line ▪ compare and order numbers from 0 up to 100; use <, > and = signs ▪ read and write numbers to at least 100 in numerals and in words ▪ use place value and number facts to solve problems. **Number – addition and subtraction** ▪ solve problems with addition and subtraction: - using concrete objects and pictorial representations, including those involving numbers, quantities and measures - applying their increasing knowledge of mental and written methods	Mathematics (Year 2)

- recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100
- add and subtract numbers using concrete objects, pictorial representations, and mentally, including:
  - a two-digit number and ones
  - a two-digit number and tens
  - two two-digit numbers
  - adding three one-digit numbers
- show that addition of two numbers can be done in any order (commutative) and subtraction of one number from another cannot
- recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems

Number – Multiplication and division

- recall and use multiplication and division facts for the 2, 5 and 10 multiplication tables, including recognising odd and even numbers
- calculate mathematical statements for multiplication and division within the multiplication tables and write them using the multiplication (×), division (÷) and equals (=) signs
- show that multiplication of two numbers can be done in any order (commutative) and division of one number by another cannot
- solve problems involving multiplication and division, using materials, arrays, repeated addition, mental methods, and multiplication and division facts, including problems in contexts.
- recognise, find, name and write fractions, measure length, identify shapes and count a set of objects or quantity
- write simple fractions for example, of 6 = 3 and recognise their equivalence.

Measurement

- choose and use appropriate standard units to estimate and measure length/height in any direction (m/cm); mass (kg/g); temperature (°C); capacity (litres/ml) to the nearest appropriate unit, using rulers, scales, thermometers and measuring vessels
- compare and order lengths, mass, volume/capacity and record the results using >, < and =
- recognise and use symbols for pounds (£) and pence (p); combine amounts to make a particular value
- find different combinations of coins that equal the same amounts of money
- solve simple problems in a practical context involving addition and subtraction of money of the same unit, including giving change
- compare and sequence intervals of time
- tell and write the time to five minutes, including quarter past/to the hour and draw the hands on a clock face to show these times
- know the number of minutes in an hour and the number of hours in a day.

Properties and shapes

- identify and describe the properties of 2-D shapes, including the number of sides and line symmetry in a vertical line
- identify and describe the properties of 3-D shapes, including the number of edges, vertices and faces
- identify 2-D shapes on the surface of 3-D shapes [for example, a circle on a cylinder and a triangle on a pyramid]
- compare and sort common 2-D and 3-D shapes and everyday objects.

Geometry – position and direction

- order and arrange combinations of mathematical objects in patterns and sequences
- use mathematical vocabulary to describe position, direction and movement, including movement in a straight line and distinguishing between rotation as

a turn and in terms of right angles for quarter, half and three-quarter turns (clockwise and anti-clockwise). **Statistics** ▪ interpret and construct simple pictograms, tally charts, block diagrams and simple tables ▪ ask and answer simple questions by counting the number of objects in each category and sorting the categories by quantity ▪ ask and answer questions about totalling and comparing categorical data	
Number – number and place value ▪ count from 0 in multiples of 4, 8, 50 and 100; find 10 or 100 more or less than a given number ▪ recognise the place value of each digit in a three-digit number (hundreds, tens, ones) ▪ compare and order numbers up to 1000 ▪ identify, represent and estimate numbers using different representations ▪ read and write numbers up to 1000 in numerals and in words ▪ solve number problems and practical problems involving these ideas. **Number – addition and subtraction** ▪ Pupils should be taught to: ▪ add and subtract numbers mentally, including: ▪ a three-digit number and ones ▪ a three-digit number and tens ▪ a three-digit number and hundreds ▪ add and subtract numbers with up to three digits, using formal written methods of columnar addition and subtraction ▪ estimate the answer to a calculation and use inverse operations to check answers ▪ solve problems, including missing number problems, using number facts, place value, and more complex addition and subtraction. **Number – multiplication and division**	Mathematics (Year 3)
Number – number and place value Pupils should be taught to ▪ count in multiples of 6, 7, 9, 25 and 1000 ▪ find 1000 more or less than a given number ▪ count backwards through zero to include negative numbers ▪ recognise the place value of each digit in a four-digit number (thousands, hundreds, tens, and ones) ▪ order and compare numbers beyond 1000 ▪ identify, represent and estimate numbers using different representations ▪ round any number to the nearest 10, 100 or 1000 ▪ solve number and practical problems that involve all of the above and with increasingly large positive numbers ▪ read Roman numerals to 100 (I to C) and know that over time, the numeral system changed to include the concept of zero and place value. **Number – addition and subtraction** ▪ add and subtract numbers with up to 4 digits using the formal written methods of columnar addition and subtraction where appropriate ▪ estimate and use inverse operations to check answers to a calculation ▪ solve addition and subtraction two-step problems in contexts, deciding which operations and methods to use and why. **Number – multiplication and division** ▪ recall multiplication and division facts for multiplication tables up to 12 × 12 ▪ use place value, known and derived facts to multiply and divide mentally, including: multiplying by 0 and 1; dividing by 1; multiplying together three numbers	Mathematics (Year 4)

- recognise and use factor pairs and commutativity in mental calculations
- multiply two-digit and three-digit numbers by a one-digit number using formal written layout
- solve problems involving multiplying and adding, including using the distributive law to multiply two digit numbers by one digit, integer scaling problems and harder correspondence problems such as n objects are connected to m objects.

Number – fractions (including decimals)

Pupils should be taught to:

- recognise and show, using diagrams, families of common equivalent fractions
- count up and down in hundredths; recognise that hundredths arise when dividing an object by one hundred and dividing tenths by ten.
- solve problems involving increasingly harder fractions to calculate quantities, and fractions to divide quantities, including non-unit fractions where the answer is a whole number
- add and subtract fractions with the same denominator
- recognise and write decimal equivalents of any number of tenths or hundredths
- recognise and write decimal equivalents to $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$
- find the effect of dividing a one- or two-digit number by 10 and 100, identifying the value of the digits in the answer as ones, tenths and hundredths
- round decimals with one decimal place to the nearest whole number
- compare numbers with the same number of decimal places up to two decimal places
- solve simple measure and money problems involving fractions and decimals to two decimal places.

Measurement

- Convert between different units of measure [for example, kilometre to metre; hour to minute]
- measure and calculate the perimeter of a rectilinear figure (including squares) in centimetres and metres
- find the area of rectilinear shapes by counting squares
- estimate, compare and calculate different measures, including money in pounds and pence
- read, write and convert time between analogue and digital 12- and 24-hour clocks
- solve problems involving converting from hours to minutes; minutes to seconds; years to months; weeks to days.

Geometry – property of shapes

- compare and classify geometric shapes, including quadrilaterals and triangles, based on their properties and sizes
- identify acute and obtuse angles and compare and order angles up to two right angles by size
- identify lines of symmetry in 2-D shapes presented in different orientations
- complete a simple symmetric figure with respect to a specific line of symmetry.

Geometry – position and direction

- describe positions on a 2-D grid as coordinates in the first quadrant
- describe movements between positions as translations of a given unit to the left/right and up/down
- plot specified points and draw sides to complete a given polygon.

Statistics

▪ interpret and present discrete and continuous data using appropriate graphical methods, including bar charts and time graphs. ▪ solve comparison, sum and difference problems using information presented in bar charts, pictograms, tables and other graphs.	
Number – number and place value ▪ read, write, order and compare numbers to at least 1 000 000 and determine the value of each digit ▪ count forwards or backwards in steps of powers of 10 for any given number up to 1 000 000 ▪ interpret negative numbers in context, count forwards and backwards with positive and negative whole numbers, including through zero ▪ round any number up to 1 000 000 to the nearest 10, 100, 1000, 10 000 and 100 000 ▪ solve number problems and practical problems that involve all of the above ▪ read Roman numerals to 1000 (M) and recognise years written in Roman numerals **Addition and subtraction** ▪ add and subtract whole numbers with more than 4 digits, including using formal written methods (columnar addition and subtraction) ▪ add and subtract numbers mentally with increasingly large numbers ▪ use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy ▪ solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why. **Number – multiplication and division** Pupils should be taught to: ▪ identify multiples and factors, including finding all factor pairs of a number, and common factors of two numbers ▪ know and use the vocabulary of prime numbers, prime factors and composite (non-prime) numbers ▪ establish whether a number up to 100 is prime and recall prime numbers up to 19 ▪ multiply numbers up to 4 digits by a one- or two-digit number using a formal written method, including long multiplication for two-digit numbers ▪ multiply and divide numbers mentally drawing upon known facts ▪ divide numbers up to 4 digits by a one-digit number using the formal written method of short division and interpret remainders appropriately for the context ▪ multiply and divide whole numbers and those involving decimals by 10, 100 and 1000 ▪ recognise and use square numbers and cube numbers, and the notation for squared (2) and cubed (3) ▪ solve problems involving multiplication and division including using their knowledge of factors and multiples, squares and cubes ▪ solve problems involving addition, subtraction, multiplication and division and a combination of these, including understanding the meaning of the equals sign ▪ solve problems involving multiplication and division, including scaling by simple fractions and problems involving simple rates. **Number – fractions (including decimals and percentages)** ▪ compare and order fractions whose denominators are all multiples of the same number ▪ identify, name and write equivalent fractions of a given fraction, represented visually, including tenths and hundredths	Mathematics (Year 5)

- recognise mixed numbers and improper fractions and convert from one form to the other and write mathematical statements > 1 as a mixed number [for example, + = = 1]
- add and subtract fractions with the same denominator and denominators that are multiples of the same number
- multiply proper fractions and mixed numbers by whole numbers, supported by materials and diagrams
- read and write decimal numbers as fractions [for example, 0.71 = $\frac{71}{100}$]
- recognise and use thousandths and relate them to tenths, hundredths and decimal equivalents
- round decimals with two decimal places to the nearest whole number and to one decimal place
- read, write, order and compare numbers with up to three decimal places
- solve problems involving number up to three decimal places
- recognise the per cent symbol (%) and understand that per cent relates to 'number of parts per hundred', and write percentages as a fraction with denominator 100, and as a decimal
- solve problems which require knowing percentage and decimal equivalents of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{2}{5}$, $\frac{4}{5}$ and those fractions with a denominator of a multiple of 10 or 25.

Measurement

- convert between different units of metric measure (for example, kilometre and metre; centimetre and metre; centimetre and millimetre; gram and kilogram; litre and millilitre)
- understand and use approximate equivalences between metric units and common imperial units such as inches, pounds and pints
- measure and calculate the perimeter of composite rectilinear shapes in centimetres and metres
- calculate and compare the area of rectangles (including squares), and including using standard units, square centimetres (cm2) and square metres (m2) and estimate the area of irregular shapes
- estimate volume [for example, using 1 cm3 blocks to build cuboids (including cubes)] and capacity [for example, using water]
- solve problems involving converting between units of time
- use all four operations to solve problems involving measure [for example, length, mass, volume, money] using decimal notation, including scaling.

Geometry – properties of shapes

- identify 3-D shapes, including cubes and other cuboids, from 2-D representations
- know angles are measured in degrees: estimate and compare acute, obtuse and reflex angles
- draw given angles, and measure them in degrees (o)
- identify:
  - angles at a point and one whole turn (total 360o)
  - angles at a point on a straight line and $\frac{1}{2}$ a turn (total 180o)
  - other multiples of 90o
- use the properties of rectangles to deduce related facts and find missing lengths and angles
- distinguish between regular and irregular polygons based on reasoning about equal sides and angles.

Geometry – position and direction

▪ identify, describe and represent the position of a shape following a reflection or translation, using the appropriate language, and know that the shape has not changed **Statistics** ▪ solve comparison, sum and difference problems using information presented in a line graph ▪ complete, read and interpret information in tables, including timetables.	
Number – number and place value ▪ read, write, order and compare numbers up to 10 000 000 and determine the value of each digit ▪ round any whole number to a required degree of accuracy ▪ use negative numbers in context, and calculate intervals across zero ▪ solve number and practical problems that involve all of the above. **Number - addition, subtraction, multiplication and division** ▪ multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication ▪ divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division, and interpret remainders as whole number remainders, fractions, or by rounding, as appropriate for the context ▪ divide numbers up to 4 digits by a two-digit number using the formal written method of short division where appropriate, interpreting remainders according to the context ▪ perform mental calculations, including with mixed operations and large numbers ▪ identify common factors, common multiples and prime numbers ▪ use their knowledge of the order of operations to carry out calculations involving the four operations ▪ solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why ▪ solve problems involving addition, subtraction, multiplication and division ▪ use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy. **Number – fractions (including decimals and percentages)** ▪ use common factors to simplify fractions; use common multiples to express fractions in the same denomination ▪ compare and order fractions, including fractions > 1 ▪ add and subtract fractions with different denominators and mixed numbers, using the concept of equivalent fractions ▪ multiply simple pairs of proper fractions, writing the answer in its simplest form [for example, $\frac{1}{4} \times \frac{1}{2} = \frac{1}{8}$] ▪ divide proper fractions by whole numbers [for example, $\frac{1}{3} \div 2 = \frac{1}{6}$] ▪ associate a fraction with division and calculate decimal fraction equivalents [for example, 0.375] for a simple fraction [for example, $\frac{3}{8}$] ▪ identify the value of each digit in numbers given to three decimal places and multiply and divide numbers by 10, 100 and 1000 giving answers up to three decimal places ▪ multiply one-digit numbers with up to two decimal places by whole numbers ▪ use written division methods in cases where the answer has up to two decimal places ▪ solve problems which require answers to be rounded to specified degrees of accuracy ▪ recall and use equivalences between simple fractions, decimals and percentages, including in different contexts.	Mathematics (Year 6)

Ratio and proportion:
- solve problems involving the relative sizes of two quantities where missing values can be found by using integer multiplication and division facts
- solve problems involving the calculation of percentages [for example, of measures, and such as 15% of 360] and the use of percentages for comparison
- solve problems involving similar shapes where the scale factor is known or can be found
- solve problems involving unequal sharing and grouping using knowledge of fractions and multiples.

Algebra:

Pupils should be taught to:
- use simple formulae
- generate and describe linear number sequences
- express missing number problems algebraically
- find pairs of numbers that satisfy an equation with two unknowns
- enumerate possibilities of combinations of two variables.

Measurement:
- solve problems involving the calculation and conversion of units of measure, using decimal notation up to three decimal places where appropriate
- use, read, write and convert between standard units, converting measurements of length, mass, volume and time from a smaller unit of measure to a larger unit, and vice versa, using decimal notation to up to three decimal places
- convert between miles and kilometres
- recognise that shapes with the same areas can have different perimeters and vice versa
- recognise when it is possible to use formulae for area and volume of shapes
- calculate the area of parallelograms and triangles
- calculate, estimate and compare volume of cubes and cuboids using standard units, including cubic centimetres (cm3) and cubic metres (m3), and extending to other units [for example, mm3 and km3].

Geometry - properties or shapes
- draw 2-D shapes using given dimensions and angles
- recognise, describe and build simple 3-D shapes, including making nets
- compare and classify geometric shapes based on their properties and sizes and find unknown angles in any triangles, quadrilaterals, and regular polygons
- illustrate and name parts of circles, including radius, diameter and circumference and know that the diameter is twice the radius
- recognise angles where they meet at a point, are on a straight line, or are vertically opposite, and find missing angles.

Geometry – position and direction
- describe positions on the full coordinate grid (all four quadrants)
- draw and translate simple shapes on the coordinate plane, and reflect them in the axes.

Statistics
- interpret and construct pie charts and line graphs and use these to solve problems
- calculate and interpret the mean as an average.

9.1.10.2 Science

Lower key stage 1 – years 1 and 2

Topic	Subject
▪ identify and name a variety of common wild and garden plants, including deciduous and evergreen trees ▪ Identify and describe the basic structure of a variety of common flowering plants, including trees.	Plants (Year 1)
▪ identify and name a variety of common animals including fish, amphibians, reptiles, birds and mammals ▪ identify and name a variety of common animals that are carnivores, herbivores and omnivores ▪ describe and compare the structure of a variety of common animals (fish, amphibians, reptiles, birds and mammals, including pets) ▪ identify, name, draw and label the basic parts of the human body and say which part of the body is associated with each sense.	Animals, including humans (Year 1)
▪ distinguish between an object and the material from which it is made ▪ identify and name a variety of everyday materials, including wood, plastic, glass, metal, water, and rock ▪ describe the simple physical properties of a variety of everyday materials ▪ compare and group together a variety of everyday materials on the basis of their simple physical properties.	Everyday materials (Year 1)
▪ observe changes across the four seasons ▪ observe and describe weather associated with the seasons and how day length varies.	Seasonal changes (Year 1)
▪ explore and compare the differences between things that are living, dead, and things that have never been alive ▪ identify that most living things live in habitats to which they are suited and describe how different habitats provide for the basic needs of different kinds of animals and plants, and how they depend on each other ▪ identify and name a variety of plants and animals in their habitats, including micro-habitats ▪ Describe how animals obtain their food from plants and other animals, using the idea of a simple food chain, and identify and name different sources of food.	Living things and their habitats (Year 2)
▪ observe and describe how seeds and bulbs grow into mature plants ▪ find out and describe how plants need water, light and a suitable temperature to grow and stay healthy.	Plants (Year 2)
▪ notice that animals, including humans, have offspring which grow into adults ▪ find out about and describe the basic needs of animals, including humans, for survival (water, food and air) ▪ describe the importance for humans of exercise, eating the right amounts of different types of food, and hygiene.	Animals, including humans (Year 2)
▪ identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses ▪ find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching.	Uses of everyday materials (Year 2)

Lower key stage 2 – years 3 and 4

Topic	Subject
▪ asking relevant questions and using different types of scientific enquiries to answer them ▪ setting up simple practical enquiries, comparative and fair tests	Scientific methods (Years 3 and 4)

▪ making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers ▪ gathering, recording, classifying and presenting data in a variety of ways to help in answering questions ▪ recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables ▪ reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions ▪ using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions ▪ identifying differences, similarities or changes related to simple scientific ideas and processes ▪ using straightforward scientific evidence to answer questions or to support their findings.	
▪ identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves and flowers ▪ explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant ▪ investigate the way in which water is transported within plants ▪ explore the part that flowers play in the life cycle of flowering plants, including pollination, seed formation and seed dispersal.	Plants (Year 4)
▪ identify that animals, including humans, need the right types and amount of nutrition, and that they cannot make their own food; they get nutrition from what they eat ▪ identify that humans and some other animals have skeletons and muscles for support, protection and movement.	Animals, including humans (Year 4)
▪ compare and group together different kinds of rocks on the basis of their appearance and simple physical properties ▪ describe in simple terms how fossils are formed when things that have lived are trapped within rock ▪ recognise that soils are made from rocks and organic matter.	Rocks (Year 4)
▪ recognise that they need light in order to see things and that dark is the absence of light ▪ notice that light is reflected from surfaces ▪ recognise that light from the sun can be dangerous and that there are ways to protect their eyes ▪ recognise that shadows are formed when the light from a light source is blocked by an opaque object ▪ find patterns in the way that the size of shadows change.	Light (Year 4)
▪ compare how things move on different surfaces ▪ notice that some forces need contact between two objects, but magnetic forces can act at a distance ▪ observe how magnets attract or repel each other and attract some materials and not others ▪ compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials ▪ describe magnets as having two poles ▪ predict whether two magnets will attract or repel each other, depending on which poles are facing.	Forces and magnets (Year 4)
▪ recognise that living things can be grouped in a variety of ways ▪ explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment	Living things and their habitats

▪ recognise that environments can change and that this can sometimes pose dangers to living things.	
▪ describe the simple functions of the basic parts of the digestive system in humans ▪ identify the different types of teeth in humans and their simple functions ▪ construct and interpret a variety of food chains, identifying producers, predators and prey.	Animals, including humans (Year 4)
▪ compare and group materials together, according to whether they are solids, liquids or gases ▪ observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C) ▪ identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature.	States of matter (Year 4)
▪ identify how sounds are made, associating some of them with something vibrating ▪ recognise that vibrations from sounds travel through a medium to the ear ▪ find patterns between the pitch of a sound and features of the object that produced it ▪ find patterns between the volume of a sound and the strength of the vibrations that produced it ▪ recognise that sounds get fainter as the distance from the sound source increases.	Sound (Years 5 and 6)
▪ identify common appliances that run on electricity ▪ construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers ▪ identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery ▪ recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit ▪ recognise some common conductors and insulators, and associate metals with being good conductors.	Electricity (Years 5 and 6)
▪ identify common appliances that run on electricity ▪ construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers ▪ identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery ▪ recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit ▪ recognise some common conductors and insulators, and associate metals with being good conductors.	Electricity (years 5 and 6)
▪ describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird ▪ Describe the life process of reproduction in some plants and animals.	Living things and their habitats (Years 5 and 6)
▪ Describe the changes as humans develop to old age.	Animals, including humans (Years 5 and 6)
▪ compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets	Year 4 and 5

▪ know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution ▪ use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating ▪ give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic ▪ demonstrate that dissolving, mixing and changes of state are reversible changes ▪ explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.	
▪ describe the movement of the Earth, and other planets, relative to the Sun in the solar system ▪ describe the movement of the Moon relative to the Earth ▪ describe the Sun, Earth and Moon as approximately spherical bodies ▪ use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky.	Earth and space (Year 4 and 5)
▪ explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object ▪ identify the effects of air resistance, water resistance and friction, that act between moving surfaces ▪ Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.	Forces (Year 4 and 5)
▪ describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro-organisms, plants and animals ▪ Give reasons for classifying plants and animals based on specific characteristics.	Living things and their habitats (Year 6)
▪ identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood ▪ recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function ▪ Describe the ways in which nutrients and water are transported within animals, including humans.	Animals, including humans (Year 6)
▪ recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago ▪ recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents ▪ Identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution.	Evolution and inheritance (Year 6)
▪ recognise that light appears to travel in straight lines ▪ use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye ▪ explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes ▪ use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them.	Light (Year 6)
▪ associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit ▪ compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches ▪ Use recognised symbols when representing a simple circuit in a diagram.	Electricity (Year 6)

9.1.11 Spain

9.1.11.1 Sciences

Topic	Subject
Introduction to scientific activity Introduction to scientific activity. Experimental approach to some questions. Searching, selection and organization of concrete and relevant information. Analysis, obtention of conclusions, communication of experiences, reflection on processes followed and communication of them orally and in writing. ▪ Uses own means of observation. ▪ Manifests autonomy in the planning and execution of actions and tasks and has initiative in making decisions. Usage of different sources of information. Reading of texts from a same area. ▪ Consultation and usage of written documents, images and graphics. ▪ Development of appropriate strategies to access information from scientific texts. ▪ Appropriate usage of the vocabulary corresponding to each of the content blocks. Usage of information and communication technologies to search and select information, to simulate processes and to present conclusions. ▪ Orally exposure, in a clear and orderly manner, of contents related to the area, demonstrating the comprehension of oral and/or written texts. Habits of prevention of illnesses and accidents, in the classroom and in the centre. Usage of various materials, taking into account safety regulations. ▪ Usage of text processing autonomously (page adjustment, inserting illustrations or notes, etc.). ▪ It makes appropriate use of information and communication technologies as a leisure resource. ▪ Know and use the measures of protection and personal security that you must use in the use of information and communication technologies. ▪ Presents the work in an orderly, clear, clean, on paper, and digital. ▪ Usage of strategies to perform work individually and as a team, showing skills for a peaceful resolution of conflicts. ▪ Knowledge and respect for rules of use and safety of instruments and work materials. Individual and group work. Study and work techniques. Development of work habits. Effort and responsibility. Project planning and reporting. Realization of projects. ▪ Making of simple experiences and small investigations: posing of problems, statement of hypotheses, selection of the necessary materials, making and drawing of conclusions and communication of the results. ▪ Making of a project, working individually or as a team and presentation of a report, using paper and/or digital support, collection of information from different sources (direct, books, Internet), usage of different media and orally communication of the experience, support in images and written texts.	Natural Sciences (Year 1)

Health and the human being The human body and its functioning. Anatomy and physiology. Apparatus and systems. The vital functions in the human being: Relationship function (sense organs, nervous system, locomotor system). Nutrition function (respiratory, digestive, circulatory and excretory apparatus). Relationship function (sense organs, nervous system, locomotor system). Nutrition function (respiratory, digestive, circulatory and excretory apparatus). Play function (player device). ▪ Identification and location of the main organs involved in the performance of the vital functions of the human body: Nutrition (respiratory, digestive, circulatory and excretory apparatus), Reproduction (reproductive system), Relationship (sense organs, nervous system, locomotor system). Health and sickness. Main diseases that affect the apparatus and systems of the human organism. ▪ Identification and description of the main characteristics of the human being vital functions. ▪ Identification of the main characteristics of the (respiratory, digestive, locomotor, circulatory and excretory apparatus) and explanation of its main functions. Healthy habits to prevent diseases Responsible behaviour. Harmful effects of alcohol and drug use. Advances in science that improve life. ▪ Recognition of healthy lifestyles and their effects on the care and maintenance of different organs and devices. ▪ Identification and value of healthy habits to prevent illness and maintain responsible behaviour. ▪ Identification and adoption of habits of hygiene care and rest. ▪ Knowledge and explanation of the principles of balanced diets, identifying healthy practices to prevent and detect health risks. ▪ Recognition of the harmful effects of alcohol and drug use. ▪ Observation, identification and description of some advances in science that improve health (medicine, food production and preservation, water purification, etc.). ▪ Knowing and usage of first aid techniques, in simulated and real situations. ▪ Identification of emotions and feelings of their own, their peers and adults manifesting empathic behaviours. Knowledge of basic first aid actions. Knowledge of yourself and others. Identity and personal autonomy. The relationship with others. Decision-making: criteria and consequences. The peaceful resolution of conflicts. Equality between men and women. ▪ Knowledge and application of strategies to study and work effectively. ▪ Reflection on the work done, drawing of conclusions about how he works, learning and development of strategies to continue learning. ▪ Autonomously and creatively planning of leisure activities and free time, as an individual and in-group. ▪ Manifestation of autonomy in the planning and execution of actions and tasks. Development of initiative in decision-making, identification of the criteria and the consequences of the decisions taken.	Natural Sciences (Year 2)
Human beings Know the structure of living beings cells, tissues, types, organs, devices and systems: identifying the main characteristics and functions.	Natural Sciences (Year 3)

▪ Identify and explain the differences between living beings and inert beings. ▪ Identifies and describes the structure of living beings: cells, tissues, organs, devices and systems, identifying the main characteristics and functions of each one of them. Know different levels of classification of living beings, according to their characteristics and types. ▪ Observe and identify the characteristics and classify living beings: Animal Kingdom. Kingdom of plants. Kingdom of fungi. Other kingdoms. ▪ Observe directly and indirectly, identify characteristics, recognize and classify, invertebrate animals. ▪ Observes directly and indirectly, identifies characteristics, recognizes and classifies vertebrate animals. ▪ Observe directly and indirectly, identify characteristics and classify plants. ▪ Use guides in the identification of animals and plants. ▪ Explains the importance of photosynthesis for life on Earth. Know the characteristics and components of an ecosystem. ▪ Identify and explain the relationships between living beings. Food chains Populations, communities and ecosystems. ▪ Identify and explain some of the causes of the extinction of species. ▪ Observe and identify the main characteristics and components of an ecosystem. ▪ Recognize and explain some ecosystems: meadow, pond, forest, coast and city, and the living beings that inhabit them. ▪ Observe and identify different habitats of living beings. Usar medios tecnológicos, respetando las normas de uso, de seguridad y de respetando las normas de uso, de seguridad y de mantenimiento de los instrumentos de observación y de los materiales de trabajo, mostrando interés por la observación y el estudio riguroso de todos los seres vivos, y hábitos de respeto y cuidado hacia los seres vivos. ▪ Shows behaviours of respect and care towards living beings. ▪ Use the magnifying glass and other technological means in the different jobs he does. ▪ It shows a certain precision and rigor in the observation and in the elaboration of the works. ▪ Observe and record some process associated with the life of living beings, using the instruments and the appropriate audiovisual and technological means, communicating the results orally and in writing. ▪ Respect the rules of use, safety and maintenance of the observation instruments and work materials.	
Materials and energy Study and classification of some materials for their properties. Usefulness of some advances, products and materials for the progress of society. Different procedures for measuring the mass and volume of a body. ▪ Observe, identify, describe and classify some materials by their properties (hardness, solubility, state of aggregation, thermal conductivity). Explanation of observable physical phenomena in terms of density differences. The buoyancy in a liquid medium. Prediction of changes in the movement or in the shape of bodies by the effect of forces.	Natural Sciences (Year 4)

▪ It uses different procedures to measure the mass and volume of a body. ▪ Identify and explain observable physical phenomena in terms of density differences. ▪ Identify and explain the main characteristics of buoyancy in a liquid medium. Energy concept Different forms of energy. Sources of energy and raw materials: its origin. Renewable and non-renewable energy. ▪ Know the basic laws that govern phenomena, such as the reflection of light, the transmission of electric current. ▪ Know the basic laws that govern the change of state, chemical reactions: combustion, oxidation and fermentation. Light as an energy source. Electricity: the electric current. Electrical circuits. Magnetism: the terrestrial magnetism. The magnet: the compass. ▪ Plan and perform simple experiences and predict changes in the movement, in the shape or in the state of the bodies by the effect of forces or energy contributions, communicating the process followed and the result obtained. ▪ It identifies and explains some of the main characteristics of the different forms of energy: mechanical, light, sound, electrical, thermal, and chemical. ▪ Identify and explain some of the main characteristics of renewable and non-renewable energies, identifying the different sources of energy and raw materials and the origin from which they come. ▪ Identify and explain the benefits and risks related to the use of energy: depletion, acid rain, radioactivity, exposing possible actions for sustainable development. ▪ Performs simple experiences to separate the components of a mixture by: distillation, filtration, evaporation or dissolution, communicating orally and in writing the process followed and the result obtained. Planning and realization of diverse experiences to study the properties of commonly used materials and their behavior in light, sound, heat, humidity and electricity. Sources of energy and raw materials: its origin. Renewable and non-renewable energy. Light as an energy source. Electricity: the electric current. Electrical circuits. Magnetism: the terrestrial magnetism. The magnet: the compass. Planning and realization of diverse experiences to study the properties of commonly used materials and their behavior in light, sound, heat, humidity and electricity. Observation of some phenomena of an electrical nature and its effects (light and heat). Attraction and repulsion of electric charges. Separation of components of a mixture by distillation, filtration, evaporation or dissolution. Chemical reactions: combustion, oxidation and fermentation. Usefulness of some advances, products and materials for society. Renewable and non-renewable energy sources. The energetic, sustainable and equitable development. ▪ Identifies and exposes the main characteristics of chemical reactions; combustion, oxidation and fermentation. ▪ Separate the components of a mixture by distillation, filtration, evaporation or dissolution.	

▪ Observes systematically, appreciates and explains the effects of heat on the increase of temperature and expansion of some materials. ▪ Identify, experiment and exemplify arguing some changes of state and its reversibility. ▪ Research through the realization of simple experiences on different physical and chemical phenomena of the matter: raising problems, stating hypotheses, selecting the necessary material, drawing conclusions, communicating results, showing competence in each of the phases, as well as knowledge of the basic laws that govern the phenomena studied. ▪ Research through the realization of simple experiences to approach the knowledge of the basic laws that govern phenomena, such as the reflection of light, the transmission of electric current, the change of state, chemical reactions: combustion, oxidation and the fermentation. ▪ Respect the rules of use, safety and conservation of instruments and work materials in the classroom and in the center.	
Technology, objects and machines Machines and devices Types of machines in everyday life and their usefulness. Analysis of operators and use in the construction of an apparatus. Construction of simple structures that fulfil a function or condition to solve a problem from modulated parts. ▪ Identify different types of machines, and classify them according to the number of pieces, how to operate them, and the action they perform. ▪ Observe, identify and describe some of the components of the machines. ▪ Observe and identify some of the applications of machines and appliances, and their usefulness in facilitating human activities. Electricity in the development of machines. Elements of electrical circuits. ▪ Build a simple structure that fulfills a function or condition to solve a problem from modulated pieces (ladder, bridge, slide, etc.). Effects of electricity. Conductors and insulators. The relationship between electricity and magnetism. ▪ Observe and identify the elements of an electrical circuit and build one. ▪ Observe, identify and explain some effects of electricity. ▪ He exhibits examples of conductive and insulating materials, arguing his exposition. ▪ Observe and identify the main characteristics and magnets and relate the electricity and magnetism. ▪ Meet and explain some of the great discoveries and inventions of humanity. Science: present and future of society. Benefits and risks of technologies and products. Important discoveries and inventions. ▪ Prepare a report as a technique for recording a work plan, communicating the conclusions orally and in writing. ▪ Values and describes the influence of technological development on living conditions and work. ▪ Knows and explains some of the advances of science in: home and everyday life, medicine, culture and leisure, art, music, film and sports and information and communication technologies. ▪ Treatment of texts. Guided search for information on the network. Control of time and responsible use of information and communication technologies. ▪ Performs guided searches of information in the network. ▪ Knows and applies strategies for access and work on the Internet. ▪ Usage of some available resources provided by information technologies to communicate and collaborate.	Natural Sciences (year 5)

9.1.11.2 Mathematics

Topic	Subject
Processes, methods and attitudes in mathematics Planning the problem solving process: ▪ Analysis and understanding of the statement. ▪ Strategies and procedures put into practice: make a drawing, a table, a diagram of the situation, trial and error reasoned, appropriate mathematical operations, etc. ▪ Results obtained. Approach of small investigations in numerical, geometric and functional contexts. ▪ Communicates verbally in a reasoned manner the process followed in solving a problem in mathematics or in contexts of reality. ▪ Analyse and understand the statement of problems (data, relationships between the data, context of the problem). ▪ Use heuristic strategies and reasoning processes in solving problems. ▪ Reflect on the problem solving process: review the operations used, the units of the results, check and interpret the solutions in the context of the situation, look for other ways of solving, etc. ▪ It makes estimations and elaborates conjectures on the results of the problems to solve, contrasting their validity and valuing their usefulness and effectiveness. ▪ Identify and interpret data and messages of simple numerical texts of daily life (invoices, advertising brochures, rebates ...). Approach to the method of scientific work by studying some of its characteristics and its practice in simple situations. Confidence in one's own abilities to develop appropriate attitudes and face the difficulties of scientific work. ▪ Identify patterns, regularities and mathematical laws in situations of change, in numerical, geometric and functional contexts. ▪ Make predictions about the expected results, using the patterns and laws found, analysing their suitability and the errors that occur. ▪ Deepen into problems once solved, analysing the coherence of the solution and looking for other ways to solve them. Use of technological means in the learning process to obtain information, perform numerical calculations, solve problems and present results. Integration of information and communication technologies in the learning process.	Mathematics
Numbers Whole numbers, decimals and fractions: The Roman numeration. Numerical order Use of ordinal numbers. Comparison of numbers Name and graph of the numbers of more than six figures. Equivalences between the elements of the Decimal Numbering System: units, tens, hundreds, etc.	Mathematics

▪ Identify Roman numerals by applying knowledge to the understanding of dating. ▪ Reads, writes and orders numeric and everyday texts, numbers (natural, fractions and decimals up to thousandths), using appropriate reasoning and interpreting the position value of each of their figures. ▪ Use ordinal numbers in real contexts. ▪ Interpret in numbers and everyday texts, numbers (natural, fractions and decimals up to thousandths), using appropriate reasoning and interpreting the position value of each of its figures. ▪ It decomposes, composes and rounds natural numbers and decimals, interpreting the position value of each one of its figures. ▪ Order integers, decimals and basic fractions by comparison, representation on the number line and transformation of one another. ▪ Use negative numbers in real contexts. The Decimal Numbering System: positional value of the figures. The decimal number: tenths, hundredths and thousandths. Concept of fraction as relationship between the parts and the whole. Own and improper fractions. Mixed number Graphic representation. Equivalent fractions, reduction of two or more fractions to a common denominator. The decimal numbers: position value. Rounding of decimal numbers to the nearest tenth, hundredth or thousandth. Relationship between fraction and decimal number, application to the ordering of fractions. ▪ Reduce dos o más fracciones a común denominador y calcula fracciones equivalentes. ▪ Redondea números decimales a la décima, centésima o milésima más cercana. ▪ Ordena fracciones aplicando la relación entre fracción y número decimal. Divisibility: multiples, divisors, prime numbers and compound numbers. Divisibility criteria. Positive and negative numbers. Estimation of results. Checking results using arithmetic strategies. Rounding of natural numbers to the tens, hundreds and thousands. Ordination of sets of numbers of different types. ▪ Know and apply the divisibility criteria by 2, 3, 5, 9 and 10. Operations: Operations with natural numbers: addition, subtraction, multiplication and division. Multiplication as the sum of equal addends and vice versa. The multiplication tables. Power as a product of equal factors. Squares and cubes. Base powers 10. Identification and use of the terms of the division. Properties of operations and relationships between them using natural numbers. Operations with fractions. Operations with decimal numbers. ▪ Operates with the numbers knowing the hierarchy of operations. ▪ It uses different types of numbers in real contexts, establishing equivalences among them, identifying them and using them as operators in the interpretation and resolution of problems.	

▪ Estimate and check results using different strategies. ▪ Performs operations with natural numbers: addition, subtraction, multiplication and division. ▪ Identify and use the proper terms of multiplication and division. ▪ Solve problems using multiplication to make counts, in rectangular arrangements in which the law of the product intervenes. ▪ Calculate squares, cubes and powers of base 10. ▪ Applies the properties of the operations and the relationships between them. ▪ Make additions and subtractions of fractions with the same denominator. Calculate the product of a fraction by a number. ▪ Perform operations with decimal numbers. ▪ Applies the hierarchy of operations and the uses of parentheses. ▪ Calculate percentages of a quantity. Percentages and proportionality. Percentages: Expression of parts using percentages. Correspondence between simple fractions, decimals and percentages. Percentage increases and decreases. Direct proportionality The rule of three in situations of direct proportionality: law of double, triple, half. Resolution of problems of daily life. ▪ Use the percentages to express parts. ▪ It establishes the correspondence between simple fractions, decimals and percentages. ▪ Calculate percentage increases and decreases. ▪ Use the rule of three in situations of direct proportionality: law of double, triple, half, to solve problems of daily life. ▪ Solves problems of daily life using percentages and rule of three in situations of direct proportionality, explaining orally and in writing the meaning of the data, the situation, the process followed and the solutions obtained. Calculation: Use of the standard algorithms of addition, subtraction, multiplication and division. Automation of algorithms. Decomposition, additively and additively multiplicative. Decomposition of natural numbers according to the positional value of their figures. Construction of ascending and descending series. Construction and memorization of multiplication tables. Obtaining the first multiples of a given number. Obtaining all divisors of any number less than 100. Decomposition of decimal numbers according to the positional value of their figures. Calculation of so many percent in real situations. Development and use of mental calculation strategies. ▪ Uses and automates standard algorithms of addition, subtraction, multiplication and division with different types of numbers, in checking results in contexts of problem solving and in everyday situations. ▪ It decomposes additively and in an additive-multiplicative form, numbers less than one million, taking into account the positional value of its figures.	

▪ Construct numeric, ascending and descending series of cadences 2, 10, 100 from any number and cadences 5, 25 and 50 from multiples of 5, 25 and 50. ▪ It decomposes natural numbers according to the positional value of its figures. ▪ Build and memorize the multiplication tables, using them to perform mental calculation. ▪ Identify multiples and divisors, using the multiplication tables. ▪ Calculate the first multiples of a given number. ▪ Calculate all divisors of any number less than 100. ▪ Calculate the m.c.m. and the m.c.d. ▪ It decomposes decimal numbers based on the positional value of its figures. ▪ Calculate so many percent in real situations. ▪ Elaborate and use mental calculation strategies. ▪ Estimate and round the result of a calculation by evaluating the answer. ▪ Use the calculator applying the rules of its operation, to investigate and solve problems. Use of the calculator. ▪ Solve problems that imply mastery of the contents worked, using heuristic strategies, reasoning (classification, recognition of relationships, and use of counterexamples), creating conjectures, constructing, arguing, and making decisions, valuing the consequences of them and the convenience of its use. ▪ Reflect on the process applied to problem solving: reviewing the operations used, the units of the results, checking and interpreting the solutions in the context, looking for other ways to solve it.	
Measurements Units of the Decimal Metric System. ▪ Identifies the units of the Metric Decimal System. Length, capacity, mass, surface and volume. Length, capacity, mass, surface and volume: Equivalence between capacity and volume measures. Expression e simple form of a measurement of length, capacity or mass, in complex form and vice versa. Comparison and ordering of measures of the same magnitude. Development of strategies to measure figures accurately and approximate. Choice of the most appropriate unit for the expression of a measure. ▪ Estimate lengths, capacities, masses, surfaces and volumes of known objects and spaces; choosing the unit and the most appropriate instruments to measure and express a measure, explaining orally the process followed and the strategy used. ▪ Measures with instruments, using conventional and non-conventional strategies and units, choosing the most appropriate unit for the expression of a measurement. Performing measurements. Comparison of surfaces of flat figures by superposition, decomposition and measurement. Add and subtract measures of length, capacity, mass, surface and volume.	Mathematics

Estimation of lengths, capacities, masses, surfaces and volumes of known objects and spaces; choice of the unit and the most appropriate instruments to measure and express a measure.

- Add and subtract measures of length, capacity, mass, surface and volume in simple form giving the result in the determined unit beforehand.
- It expresses in simple form the measurement of length, capacity or mass given in complex form and vice versa.
- Compare and order measures of the same magnitude.
- Compare surfaces of flat figures by superposition.

Oral and written explanation of the process followed and the strategy used in any of the procedures used.

- Knows and uses the equivalences between measures of capacity and volume.
- Explain orally and in writing the processes followed and the strategies used in all the procedures performed.
- Solve problems using the most common units of measure, converting units into others of the same magnitude, expressing the results in the most appropriate units of measure, explaining orally and in writing, the process followed.

Time measurement: Units of measure of time and their relations. Equivalences and transformations between hours, minutes and seconds. Reading on analogue and digital clocks. Calculations with temporary measures.

- Knows and uses units of measure of time and their relationships. Second, minute, hour, day, week and year.
- Performs equivalences and transformations between hours, minutes and seconds.
- Read on analogue and digital clocks.
- Solve problems of daily life using temporal measures and their relationships.

Measurement of angles:

The sexagesimal system.

The angle as the unit of measure of an angle.

Measurement of angles.

- Identifies the angle as a measure of a turn or aperture.
- Measure angles using conventional instruments.
- Solve problems by performing calculations with angular measures.

Monetary systems:

The Monetary System of the European Union. Main unit: the euro. Value of different coins and banknotes.

Multiple and sub-multiples of the euro.

Equivalences between coins and banknotes.

Resolution of measurement problems.

- It knows the function, the value and the equivalences between the different currencies and notes of the monetary system of the European Union using them both to solve problems in real and figurative situations.
- Calculates multiples and submultiples of the euro.
- It solves measurement problems, using heuristic strategies, reasoning (classification, recognition of relationships, and use of counterexamples),

creating conjectures, constructing, arguing, and making decisions, assessing the consequences of them and the convenience of their use. ▪ Reflect on the process followed in solving problems: reviewing the operations used, the units of the results, checking and interpreting the solutions in the context, looking for other ways to solve it.	
Geometry The situation in the plane and in space. Relative positions of lines and circles. ▪ Identifies and represents relative positions of lines and circles. Angles in different positions: consecutive, adjacent, opposite by the vertex ... Cartesian coordinate system. Description of positions and movements. The elemental representation of space, scales and simple graphs. ▪ Identifies and represents angles in different positions: consecutive, adjacent, opposite by the vertex ... ▪ Describes positions and movements by means of coordinates, distances, angles, turns. ▪ Perform simple scales and graphs, to make elemental representations in space. ▪ It identifies in very simple situations the symmetry of axial type and specular. ▪ Draw a symmetrical plane figure of another with respect to an axis. ▪ Make enlargements and reductions. Flat and spatial forms: flat figures: elements, relationships and classification. Classification of triangles according to their sides and their angles. Classify triangles by looking at their sides and angles, identifying the relationships between their sides and between angles. ▪ It uses drawing instruments and technological tools for the construction and exploration of geometric forms. ▪ Calculate the area and perimeter of: rectangle, square, triangle. ▪ Applies the concepts of perimeter and surface of figures for the accomplishment of calculations on planes and real spaces and to interpret situations of the daily life. Classification of quadrilaterals according to the parallelism of their sides. Classification of the parallelepipeds. Concavity and convexity of flat figures. Identification and denomination of polygons considering the number of sides. ▪ Classify quadrilaterals according to the parallelism of their sides. ▪ Identify and differentiate basic elements of circle and circle: centre, radius, diameter, string, arc, tangent and circular sector. ▪ Calculates, perimeter and area of the circumference and circle. ▪ It uses the composition and decomposition to form flat figures and geometric bodies from others. Perimeter and area. The circumference and the circle. Basic elements: centre, radius, diameter, string, arc, tangent and circular sector. ▪ Identifies and names polygons based on the number of sides. ▪ It recognizes and identifies, polyhedral, prisms, pyramids and their basic elements: vertices, faces and edges. ▪ Recognizes and identifies round bodies: cone, cylinder, sphere, and its basic elements. Geometric bodies: elements, relationships and classification. ▪ Understand and describe situations of daily life, and interpret and elaborate spatial representations (planes, sketches of itineraries, models ...), using the basic geometric notions (situation, movement, parallelism, perpendicularity, scale, symmetry, perimeter, surface).	Mathematics

▪ Interprets and describes situations, messages and facts of daily life using the appropriate geometric vocabulary: indicates a direction, explains a route, is oriented in space. Polyhedral. Basic elements: vertices, faces and edges. Types of polyhedral. Round bodies: cone, cylinder and sphere. ▪ It solves geometric problems that imply mastery of the contents worked, using heuristic strategies, reasoning (classification, recognition of relations, and use of counterexamples), creating conjectures, constructing, arguing, and making decisions, assessing the consequences of the same and the convenience of its use. ▪ Reflect on the problem solving process: reviewing the operations used, the units of the results, checking and interpreting the solutions in the context, proposing other ways to solve it. Regularities and symmetries: Recognition of regularities.	
Statistics and probability Graphs and statistical parameters. Collection and classification of qualitative and quantitative data. ▪ It identifies qualitative and quantitative data in familiar situations. Construction of tables of absolute and relative frequencies. Intuitive introduction to centralization measures: arithmetic mean, fashion and rank. ▪ It collects and classifies qualitative and quantitative data of situations in its environment, using them to construct absolute and relative frequency tables. ▪ Applies intuitively to familiar situations, centralization measures: arithmetic mean, fashion and rank. ▪ It performs and interprets very simple graphs: bar, polygonal and sector diagrams, with data obtained from very close situations. Realization and interpretation of simple graphs: bar, polygonal and sector diagrams. Critical analysis of the information presented through statistical graphs. ▪ It performs critical analysis based on the information presented through statistical graphs. Random character of some experiences. ▪ Identify random situations. ▪ Make guesswork on some games (coins, dice, cards, lottery ...). Intuitive initiation when calculating the probability of an event. ▪ It solves problems that involve mastery of the contents of statistics and probability, using heuristic strategies, reasoning (classification, recognition of relationships, and use of counterexamples), creating conjectures, constructing, arguing, and making decisions, valuing the consequences of them and the convenience of its use. ▪ Reflect on the problem solving process: reviewing the operations used, the units of the results, checking and interpreting the solutions in the context, proposing other ways to solve it.	Mathematics

9.2 Secondary Education

9.2.1 Belgium (Flanders)

First stage (A-stream)

Subjects of interest are Geography, Natural sciences, Technology, Mathematics

9.2.1.1 Geography

Topics	Subject
Students learn to describe a real landscape, depict images with basic geographical terms and designate them on a matching map.	Landscape and maps
Students learn to read maps using legends, scale and orientation.	
Students learn to find and locate a geographic element on the maps or atlas using the table of contents and the name register.	
Students learn to recognise various landscape components, including relief areas, rivers, agricultural areas, industrial areas, agglomerations and cities, seaports, transport axes, tourist areas and tourist centres, on Flanders or Belgium and other studied areas.	
Students learn to spontaneously consult the appropriate card.	
Population and multi cultural society	
Students learn six basic concepts about population, including cultural aspects, relevant population data from maps and charts.	
Students learn to describe elements of other cultures in their own environment.	
Students learn to respect the specificity and specific way of life of people from other cultures, including in our multicultural society.	
Students learn to name rocks on based on experimental observations.	Natural environment / Soil and subsoil
Students learn to differentiate between soil and subsoil based on an image.	
Students learn to identify building materials related to rocks in their own environment	
Students learn to Identify and designate the most important elements of the topographical relief in a landscape as well as identify and name relief forms.	Topographical relief (terrain)
Students learn to recognise in a landscape and by image the effect of floods.	
Students learn to read map heights and height zones using highlights, heights and colours.	
Students learn to read the pollution levels of some Belgian rivers on a map and name the main causes of it.	
Students learn to appreciate the value of clean water.	

Students learn to express the similarities and differences between weather and climate.	Weather and climate
Students learn to explain how certain factors affect weather and climate.	
Students learn how to illustrate through examples that weather and climate influence the plant growth and animals' and humans' activities.	
Students learn to read weather and climate data from an area with the use of numbers, graphics and maps.	
Students learn to recognize a rural landscape, describe views and features and compare simple observable features to a rural landscape elsewhere.	Man and landscape / The rural landscape
Students learn to identify environmental effects that can be associated with agricultural activities.	
Students learn to approach open spaces as valuable and sustainable assets	
Students learn to recognize an industrial landscape, describe its views and features, and compare simple observable features with an industrial landscape elsewhere.	The industrial landscape
Students learn to identify environmental effects that can be associated with industrial activities.	
Students recognise an urban landscape, describe views and features and compare simple observable features to an urban landscape elsewhere.	The urban landscape
Students learn to identify environmental and societal aspects that can be associated with the urban landscape.	
Students learn how to contribute to the quality of life of their own environment.	
Students learn to describe the way traffic affects their environment	The traffic in the landscape
Students learn how to recognize and describe a port including its different activities	
Students come up with their own map/city plan intersections for the busy environment they live in	
Students learn about environmental effects that can be associated with traffic.	
Students develop a critical attitude towards the traffic situation in their own environment.	
Students learn to recognize a touristic and recreational landscape, describe its views and	The touristic and recreational landscape

features and compare it to other touristic landscapes elsewhere.	
Students learn about the effects of tourism and recreation on the landscape and the local economy.	
Students learn that as tourists they need to respect the environment, the culture and the inhabitants.	
Your own space	
Students learn how to describe and classify their living space	
Students learn how to place their own living space in the wider regional framework	

9.2.1.2 Natural Sciences

Topics	Subject
Students learn to illustrate that an organism is composed by different organizational levels (cell, tissue, organ, system, organisms);	Systems
Students learn to the construction, functioning and interdependence of human's digestive system, the respiratory system, blood, the circulatory system and the secretion system;	
Students learn about the functions of the root, stem, leaf and flower in a flower plant;	
Students learn to recognize the cell as the building block of an organism and recognize its structure at microscopic level;	
Students learn about the reproductive system in humans, how reproduction happens, indicate ways to regulate reproductive conditions and to learn how to prevent sexually transmitted diseases;	
Students learn to demonstrate with concrete examples that organisms are adapted to their environment in different ways;	
Students learn to demonstrate, using a concrete example of a biotope, that organisms form a community of life in which food relations occur;	
Students learn to demonstrate in concrete examples that the environment affects the appearance of living creatures and vice versa	
Students learn to demonstrate in a concrete example that humans influence nature and the environment and that ecological balances can be changed	
Interaction	

Students learn about the importance of metabolism for the maintenance of the human body;	
Students learn through observations that in plants substances are formed under the influence of light and soil and air substances;	
Students learn to associate visible and invisible radiation with phenomena and applications from daily life;	
Students learn to demonstrate concrete heat transfer (conduction, convection, radiation) with concrete examples;	
Students learn to determine the mass and volume of matter;	Matter
Students learn to follow concepts using the particle model: atom, molecule, pure substance, mixture, temperature, aggregation state and phase transitions;	
Students show in concrete examples of daily life that energy can have different forms and can be transformed into another form of energy	Energy
Students learn, under guidance, how a science-related problem should be approached: a research question needs to be formulated and then a hypothesis or expectation about this question	Scientific skills
Students learn how to collect data related to a research question and then execute an experiment, a measurement or a site observation according to a prescribed procedure;	
Students learn how to distinguish the essential steps of the scientific method;	
Students learn how to collect and classify data in order to make a decision;	
Students learn how to present results collected from an experiment, a measurement or a field study. This can happen in the form of an oral presentation, a table or graph, a figure or by diagram. Students also learn to use the correct names and symbols.	
Students learn to apply the correct unit for measuring mass, length, area, volume, temperature, time, pressure, speed, power and energy	
Students learn to connect scientific concepts to daily observations, concrete applications or social evolutions;	Science and society
Students learn how to connecting the importance of biodiversity to resources' scarcity and fossil energy sources to a sustainable lifestyle.	

9.2.1.3 Technology

Topics	Subject
Students learn to investigate different parts and subsystems in a technical system: explain the functions and relationships between them;	Core components of technology
Students learn how to investigate working or problematic technical systems and investigate how improvements are possible;	
Students learn how the adaptation a technical systems leads to optimization, innovation and / or new inventions;	
Students learn how to explain in concrete examples from technology which maintenance is necessary for the proper and sustainable operation of technical systems;	
Students learn, through concrete examples, to indicate the steps of the cyclic technical process: investigating, designing, manufacturing, putting into service, evaluating problem statements;	
Students learn to demonstrate using concrete examples from technology the utility, demonstration of the tools used, such as machinery, raw materials, energy, information, human effort, money, time;	
Students learn to explain using concrete examples of technical systems how choices are made for development and use of technical systems based on certain criteria;	
Students learn how to demonstrate with concrete examples of technology that energy is a necessary tool and can be transformed to different forms;	
Students learn how to demonstrate with concrete technology examples the role of controls and control systems in technical systems;	
Students learn about technical systems, technical processes, tools and choices in various applications from the world of technology including energy, information and communication, construction, transport and biochemistry.	
Students learn to define a technical problem after a need to investigate the relevant requirements;	Technology as human activity
Students learn how to use models, tests and evaluations to design a simple technical system based on a defined problem, taking into account pre-established standards and criteria;	

Students learn how to materialise a given or their own design with a view to quality, safety, ergonomics and environmental requirements;	
Students learn how to adopt a technical system	
Students learn how to evaluate a technical system based on predetermined standards and criteria and draw conclusions to optimize the technical process;	
Students go through the successive steps of the technical process to compile a simple technical system;	
Students learn how to choose and use tools according to the purpose and the use;	
Students learn how to maintain technical systems that they use frequently according to the maintenance instructions;	
Students learn about technical systems careful, purposeful, safe and ergonomic use;	
Students learn that technical systems are present in various applications from the world of technology including energy, information and communication, construction, transport and biochemistry.	
Students demonstrate through concrete examples that technical systems are designed and made to meet social and cultural needs;	Technology and society
Students learn to demonstrate through concrete examples what the positive and negative effects of technical systems are on social life and nature;	
Students learn to give examples of social choices that determine the development and use of new technical systems;	
Students learn through concrete examples that science influences choices made in the technical process;	
Students learn that technical systems vary in time and space;	
Students learn through concrete examples how one can act sustainably in the various steps of the technical process;	
Students learn to demonstrate in concrete examples which role certain technical professions fulfil during the various steps of a technical process;	
Students learn to recognize the importance of technical professions and technical skills in contemporary society and do not differentiate between men and women;	

Students learn to illustrate the mutual influence of technology and society in different fields of application in the world of technology including energy, information and communication, construction, transport and biochemistry.	

9.2.1.4 Sciences

Topics	Subject
Conceptualisation – Factual knowledge	Numbers
Students learn: To associate natural, integer and rational numbers with realistic and meaningful contexts.	
To know the rules oφ whole and rational numbers.	
To know that the properties of the operations in the set of natural numbers remain valid and can be extended in the collections of the whole and rational numbers.	
To distinguish and understand the different notations of rational numbers (fractional and decimal notation).	
To apply the appropriate terminology related to: addition, sum, sum of sum, subtraction, difference, multiplication, product, factors of a product, division, quotient, particle, divider, rest, percent, square, square root, power, base, exponent, reverse, reverse, absolute value, average.	
The students learn: To apply appointments related to the order of operations.	Procedures
To perform the main operations (addition, subtraction, multiplication and division) correctly in the collections of the natural, integer and rational numbers.	
To calculate by using properties and calculation rules of operations.	
To use a scientific calculator	
To order numbers and use the appropriate symbols (£, <, ³,>, =, inequality mark).	
To calculate powers with bases 10 and 2 with entire exponent. They apply computational rules of power.	
To estimate the outcome of an operation and judge the result;	
To use percentages in meaningful contexts.	

The students learn: To interpret a rational number as a number that determines the place of a point on a numerical axis.	Consistency between concepts
To explain the relationship between addition and subtraction, multiplication and sharing.	
To recognize how two quantities can be proportional and inversely proportional and how does this apply in real life.	
To calculate the arithmetic mean and median (for ungrouped data) from tables with numerical data and derive relevant information from this.	
	Algebra
Students learn to use letters as unknowns and a mean of generalisation	Conceptual knowledge
Procedures	
Students learn to: add and multiply two and three terms and simplify the result.	
To know the formulas for the following products: $(a + b)^2$ and $(a + b) x(a-b)$;	
To solve first degree equations with one unknown.	
To respond to simple questions that can be deduced from a first degree equation a	
The students regularly detect simple patterns and schemas and can describe them with formulas. 24 can directly represent proportional relationships with formulas from tables.	Consistency between concepts
can use simple schemas, figures, tables and diagrams.	
can use simple schemas, figures, tables and diagrams.	
	Geometry
The students Learn to use the geometrical concepts diagonal, bisector, heights, centreline, radius, angles, centre angles.	Conceptualisation-Factual knowledge
Learn to recognize parallel position, perpendicular position and symmetry in flat figures, and recognize the consistency and congruence between flat figures.	
Learn to recognize figures in the plane obtained by a shift, a mirror or a rotation.	

Learn that in a two-dimensional representation of a three-dimensional situation information is lost.	
Recognize cube, beam, straight prism, cylinder, pyramid, cone and sphere using a sketch and learn how to draw them.	
Learn about geometric features such as: the corner sieve in triangles and quadrilaterals, equilateral and equilateral triangles, angular and diagonal properties in quadrilaterals.	
The students Learn to choose suitable units and instruments to measure distances and angles with the desired accuracy.	Procedures
Learn to use the concept of scale to calculate distances in geometric figures.	
Learn to calculate the circumference and area of triangles, quadrilaterals and circles and the surface and volume of cube, beam and cylinder.	
Learn to determine the image of a simple flat geometric figure by a shift, reflection, rotation, determine symmetry axes of flat figures, lead lines, median lines and bisecting lines	
Learn form an image of a simple spatial figure with the aid of all kinds of concrete material from various flat views.	
The students Learn to describe and classify the types of triangles and the types of quadrilaterals using their properties.	Consistency between concepts
Learn to determine puns	
The students Learn to use mathematical language in simple situations.	Skills
Learn to apply communication skills in simple mathematical situations.	
Learn to apply problem solving skills, such as: • reformulating a task; • making a good sketch or a custom schedule; • entering notations, choosing unknowns; • analysing simple examples.	
The students Develop in addressing problems independently and with perseverance.	Attitudes

Develop self-regulation: orientation, planning, monitoring, self-testing and reflection.	
Develop a critical attitude towards the use of all kinds of numerical material, tables, calculations and graphics.	
Learn that mathematics not only is the end result important but also the way in which the answer is obtained.	

Second stage (B stream)

In B-stream natural sciences and technic are the same as in A stream. Differences are present in Sciences though.

9.2.1.5 Mathematics

Topics	Subject
Students learn : To reproduce drawings correctly from the board.	Visuality
To recognize, supplement, assemble and organize 2 figures.	
Students learn to To reduce a two-dimensional drawing and enlarge drawing using a grid.	Percepto motor skills
To create two-dimensional drawings and mirrors in relation to a vertical and a horizontal axis using a grid.	
To draw and three dimensional object	
Students obtain insight into the relationship between fractions, decimal numbers and percents.	Numbers
Students learn to: Make basic operations with natural numbers, including zero.	Main operations
Learn to add and subtract breaks with the result being a fraction with a denominator less than or equal to 16.	
Learn to create a decimal number and make a natural number.	
Students learn: To apply the main operations in different situations.	Mathematics in practical situations
To estimate sizes and calculate results of editing and finishing them meaningfully.	
To solve and check a calculation task.	
To work with ratios and percentages in practical situations.	

Students learn: To add, subtract, multiply and share with a pocket calculator.	Pocket calculator
To evaluate the results they receive	
To calculate the percentage of a number using a pocket calculator.	
To use a pocket calculator purposefully.	
Students learn: To compare and organize two or more similar objects without using a measurement unit.	Size and units
The terms circumference, surface, volume, content, mass, time, temperature and angle.	
The most important units and how to use their symbols correctly.	
To show the correlation between the change in the unit and the change in the measure number in relocations.	
To solve simple issues related to circumference, area, content, mass, time, temperature and angles.	
To make a choice between the most appropriate instrument to use	
To can measure and calculate quantities.	
Students learn: The different types of lines and how to draw them. 27 can accurately measure the length.	Lines
To accurately measure the lines' length.	
The students can designate and name the elements of an angle.	Angles
To designate and name the elements of an angle	
To designate and mark the angles (zero angle, acute angle, right angle, blunt angle, extended angle, full angle).	
To measure and draw angles	
The students learn To differentiate figures into space figures and spatial figures.	Space figures
To classify polygons according to the number of angles and sides.	
To classify triangles based on the number of equal sides or angles.	

To draw triangles, of which a number of conditions relating to equality of sides or angles are given.	
To classify quadrilaterals based on the number of equal sides, number of pairs of parallel sides, number of equal angles, diagonal properties.	
To draw quadrilaterals, some of which are given in terms of equality of sides or angles.	
To calculate the perimeter and area of a triangle, square and a rectangle.	
To draw a circle.	
To calculate the circumference and area of a circle with the right formula	
The students learn: To recognize a cube and a beam.	Spatial figures
To recognize a pyramid, cylinder, cone and sphere.	
To calculate the contents of a cube and a bar using the given formula.	
To process information	
To recognize a pyramid, cylinder, cone and sphere.	
To calculate the contents of a cube and a bar using the given formula.	
Students learn: To get information from charts, tables, charts, maps and scale models.	Information processing
To work with plan views and plans.	
To have insight into the concept of scale.	
To calculate an arithmetic mean.	
To work with scales with drawings and models.	
Students learn: To count in real world with money. To calculate profit, loss	Money

9.2.2 Cyprus

Subjects of interest are Biology, Geography, Mathematics, Physics, Chemistry

12-15yo

9.2.2.1 Biology

Topics	Subject

Students learn about how we study living organisms and the use of microscopes	Biology in relation to other Sciences
Students learn about the concept of classification	Diversity and classification of living organisms
Students learn about the various classification criteria	
Students learn about the classification within the animal kingdom	
Students learn about the classification of vertebrate coadministration	
Students learn about the classification of invertebrates	
Students learn about the human body and its organs	Organisation of organisms
Students learn about tissues and cells	
Students learn about the existence of specialised cells and their role	
Students study the cell theory	
Students learn about plants and what they need in order to grow	Photosynthesis
Students learn more about photosynthesis through experimentation	
Students learn about the importance of photosynthesis for life in our planet	
Students learn about the different factors that affect photosynthesis and its completion	
Students learn about the female and male reproduction organs and system	Human reproduction
Students learn about puberty and biological changes related to it	
Students learn about the factors that can guarantee a healthy pregnancy	
Students learn about the different nutrients that can be found in the different foods and why do we need them	Nutrition
Students learn about healthy lifestyle and nutritional habits	
Students learn how our digestive system is structured and operates	Digestive system
Students learn about the various diseases that threaten our digestive system	
Students learn about mechanical and chemical digestion	
Students learn about the absorption of nutrients and the energy the human body gets from them	

Students learn about the structure and operation of the circulatory system	Circulatory system
Students learn about the structure and operation of the heart	
Students learn about the structure and operation of blood vessels	
Students learn about blood and its composition	
Students learn about the technical operation of breathing	Respiratory system
Students learn about the structure and operation of the respiratory system	
Students learn about what happens to our body when there is not enough oxygen to cover our energy needs	
Students learn about the various diseases related to the respiratory system	
Students learn about the different microorganisms and the diseases they cause	Discovering the world of microbes
Students learn how are body responds to diseases and viruses	
Students learn about contagious diseases and how we can protect from them	
Students learn about the sexually transmitted diseases	
Students learn how to represent scientific data	Ecological pyramids
Students learn about the relation between scientific data from the past and future	
Students learn about humans' role in relation to environmental pollution	
Students learn about professional sports and the concept of competition	Professional sports
Students learn about the bone formation	
Students learn about muscles and how they function	

9.2.2.2 Geography

Topics	Subject
Students learn how to use maps and images	Geographical map
Students learn about orientation and geographical coordinates	
Students learn about scales and scaling in the context of maps	
Students learn about Earth's position in our solar system	Planet earth – our home

Students learn about the movements of Earth	
Students learn about climate and how it affects our way of life	
Students learn about factors that affect the climate	
Students learn about the major ecosystems and the different people living on Earth i.e. Tuareg people in Sahara, Inuit people in the Arctic	
Students learn about Earth's environmental problems, climate change and the impact they have both on humans and our planet	
Students learn about overpopulation: focus on India	The world and the sustainable growth
Students discuss about immigration and the dangers that immigrants face	
Students learn about major health risks including HIV	
Students learn about poverty and how it can be addressed	
Students learn about the meaning of sustainable growth	
Students learn about concepts like "fair trade", "energy footprint", "forest stewardship council (fsc)"	
Students learn about water as a renewable natural resource	Planet's natural resources and sustainable development
Students learn about hydrocarbons (natural gas and oil) as a non-renewable resource	
Students learn about natural hazards and disasters i.e. earthquakes, tsunamis, floods, hurricanes etc.)	Natural disasters and sustainable development
Students learn about Europe including its position, geography, climate	Discovering Europe
Students learn about the political division of Europe and the European Institutions	
Students learn about the Mediterranean sea, its importance, characteristics and possible threats	
Students learn about Danube and its importance	
Students learn about sustainable development and European Commission's focus on green energy	Sustainable development
Students learn about waste management and European Commission's related policies	
Students learn about globalisation	Globalisation
Students learn about light and heavy industry	

Students learn about the geography of Cyprus, its geology, climate, flora and fauna, natural resources, forests, demographics	Geography of Cyprus
Students learn about the economy of Cyprus including agriculture, industry, tourism, servies	

9.2.2.3 Mathematics

Topics	Subject
Students learn the properties of exponents where the index is a natural number	Real numbers
Students learn about rational numbers raised to integer exponents	
Students learn about square and cubic roots	
Students learn about properties of roots	
Students learn the Pythagorean theorem	
Students learn about monomials	Algebraic expressions
Students learn operations with monomials	
Students learn about polynomials	
Students learn the addition of polynomials	
Students learn about the multiplication of polynomials	
Students learn the division of polynomials	
Students learn about symmetry	Geometry
Parallelograms	
Orthogonal parallelograms	
Rhombuses	
Squares	
Trapezoids	
Circumference of a circle	
Area of a disk	
First order equations in one variable with one parameter	Equations and Inequalities
Solving formulas for a given variable	
Properties of inequalities	
First order inequalities	
Solving simultaneous inequalities—interval presentation	
Relations and functions	Functions
Linear functions—lines	
Special cases of linear functions	

Slope of a line	
Linear systems of two equations with two unknowns	
Proportional quantities Inversely proportional quantities	Proportional and Inversely Proportional Quantities
Measures of central tendency (i.e., mean, median, and mode)	Statistics and probability
Statistics with spreadsheets	
Experimental probability—the basic counting principle	

9.2.2.4 Physics

Topics	Subject
States of matter	Properties of Matter
Properties of liquid water	
Mass, volume, and density	
Properties of gases—pressure, compressibility, and diffusion	
Molecular model of matter	
Physical and chemical phenomena (changes)	
Forms of energy	Energy—Heat and Temperature
Energy conversion	
Measurement of temperature	
Heat, temperature, and thermal equilibrium	
Changes in state of matter	
Thermal expansion/contraction in solids, liquids, and gases	
Heat transfer—conduction, convection, and radiation	
Heat conductors and insulators	
Production of sound	Sound
Sound propagation	
Characteristics of sound	
Reflection of sound—echo and reverberation	
Sound attenuation	
Soundproofing and noise pollution	

9.2.2.5 Chemistry

Topics	Subject

The contribution of Chemistry to the modern world	
Introduction to Chemistry and the laboratory (i.e. application and use of Chemistry, laboratory equipment)	
The role of water in our lives	
Chemical elements & chemical reactions (i.e. composition of mixture, homogeneous and heterogeneous mixtures and their characteristics)	
Partitioning of mixtures	
Solutions	
Electrolytic water dissociation	
Chemical elements and chemical compounds	

15-18yo

9.2.2.6 Biology

Topics	Subject
Students learn about the chemical composition of organisms	Cell's chemical composition
Students learn about molecules and macromolecules	
Students learn about the different types of proteins	
Students learn about nucleic acids carbohydrates	
Students learn about lipids	
Students learn about eukaryotic cells and their composition	Cell
Students learn about plasma membrane and its structure	
Students learn about the different parts of the cell: nucleus , chloroplasts, mytochondria	
Students learn about how energy is transferred to cells	Metabolism
Students learn about enzymes	
Students learn about photosynthesis, the entire process and its importance	
Students learn about autochthonous and heterotrophic organisms	
Students learn about cell breathing	
Students learn about the life cycle of a cell	Genetics
Students learn about DNA and DNA transfer	
Students learn about cell division: mitosis, nuclear division	

Students learn about gene mutations and chromosomal abnormalities	
Students learn about cell division	Cell division
Students learn about DNA structure and DNA transfer	Genetic material
Students learn about mRNA	
Students learn about the beginning of Genetics and Mendel's experiments	
Students learn about heredity and thalassemia	
Students learn about blood types and Rhesus	
Students learn about the different factors affecting human health	Human health
Students learn about the various defence mechanisms of the human body	
Students learn about HIV	
Students learn about the concept of eco-systems	Human and nature
Students learn about food chains and food pyramids	
Students learn about three biochemical cycles : water, nitrogen, carbon	
Students learn about the concepts of : pollution ; biodiversity and desertification	
Students learn about the classification of organisms and their evolution	Evolution
Students learn about Lamarck's theory of evolution and they compare it with Darwin's theory	
Students learn about the theory of natural selection	
Students learn about human evolution, our family tree, the first appearance of humans	

9.2.3 Estonia

Subjects of interest are Mathematics, Biology, Geography, Chemistry, and Physics

9.2.3.1 Mathematics

Topics	Subject
Students learn to: distinguish between rational, irrational and real numbers	Numerical Quantities. Expressions. Equations and Inequalities.'
distinguish between equivalence, identity, equation and inequality;	

explain the identity transformations used to solve equations and inequalities;	
solve linear, quadratic and simplest fraction equations with one unknown and equations transformable to such equations;	
perform operations with powers and roots by transforming the latter to powers with rational number exponents;	
transform simple rational and irrational expressions;	
solve linear and root inequalities and linear inequality systems with one unknown	
solve simple word problems, including ones based on real life by means of equations and equation systems.	
define the sine, cosine and tangent of any angle;	Trigonometry
read graphs of trigonometric functions;	
transform an angle given in degrees to radians and vice versa	
transform simple trigonometric expressions	
use the formulas of triangle area and the sine and cosine theorem	
solve triangles, calculate areas of a triangle, parallelogram and polygon, calculate an arc of a circumference as a part of the length of the circumference and a sector of a circle as a part of the area of the circle;	
solve simple planimetry problems with applied content.	
explain the term ‘vector’ and the coordinates of a vector;	Vector on a Plane. Equation of Line
know a line, circumference and parabola as well as their equations and know the opposite positions of lines on a plane	
add and subtract vectors and multiply vectors by a number both geometrically and on the form of coordinate	
find the scalar product of vectors and use properties of perpendicularity and collinearity of vectors;	
compile an equation for a line if the line is determined by a point and a slope, by a slope and a starting ordinate and by two points;	
determine the mutual positions of lines on a plane;	
compile an equation for a circumference by a central point and a radius;	

draw lines, circumferences and parabolas by their equations;	
find the intersections of two lines (if one of the lines is a straight line);	
use vectors and equations for lines in geometry problems.	
distinguish between random, certain and impossible events;	Probability and Statistics
understand the concept of event probability and is able to find the number of favourable and all instances (counting, combinatorics);	
know the nature of the distribution of random variables the meaning of the numerical characteristics of random variables;	
know the terms ‘sample’ and ‘general dataset’ as well as the meaning of reliability of data classification and statistical decision;	
calculate the probability of an event and use it when solving simple problems connected with actual data;	
find the mean confidence region of a general dataset on the basis of a sample; and	
collect data and analyse it by statistical means of ICT.	
explain the term and general symbol of a function, the terms connected with the investigation of functions, and know the terms of inverse function and odd and even function;	Functions
draw graphs of the functions determined by the syllabus (both by hand and on computer);	
describe the main properties of a function by means of the graph of function;	
know the term and properties of the logarithm of a number, find the logarithm and potentiate simpler expressions;	
solve simpler exponent and logarithmic equations by means of direct use of the definitions of the power and logarithm;	
understand the nature of increase and decrease by compound interest and use it to solve simpler problems involving actual data;	
interpret quantities expressed in percentages in other subjects and in real life; and	
solve main trigonometric equations in a given interval on the basis of a graph.	
understand the terms ‘numeric’, ‘arithmetic’ and ‘geometric sequence	Sequences. Function derivative’

use the formulas of the general member of arithmetic and geometric sequence and the sum of the first nth members for simple problems based on real life	
explain the terms ‘derivative of a function’ and ‘tangent of the function graph’ and the geometric meaning of derivative of a function	
find the derivative of functions;	
compile the equation for the tangent of the function graph at a given point of tangency	
explain the relation of increase and decrease of function with the derivative of a function, the term extremum of a function and the finding the extremum	
find, as specified in the subject syllabus, the zeros, domains of positivity and negativity, domains of increase and decrease, maximum and minimum points of simple functions and draw a graph of the function on the basis of this information	
solve simple extremum problems	
recognise the geometric figures determined by the syllabus and explain the main properties of the figures	Planimetry. Integral.’
use the terms of geometry and trigonometry and their main relations when solving problems connected with actual data	
recognise the term ‘antiderivative’ and find indefinite integrals (from polynomials)	
recognise the term area under graph’ and use the Newton-Leibniz Formula to calculate a definite integral; and	
calculate the area of plane figures on the basis of a given integral.	
describe the coordinates of a point in space and the mutual positions of the straight lines and planes in space	Stereometry
explain the terms of angles between two straight lines, a line and a plane and two planes	
recognise the properties of solids and solids of revolution determined by the syllabus and the process of calculating their area and volume	
depict solid figures on a plane and their simple cross sections with a plane (for instance, axial cross section, parallel cross section with a single face);	
calculate the line elements, areas and volumes of the solids determined by the syllabus	

use knowledge in trigonometry and planimetry to solve simple stereometrical problems	
use solid figures as models to solve problems connected with actual data.	

9.2.3.2 Biology

Topics	Subject
compare the characteristics of organic and inorganic nature of substances and recognise aspects characteristic of the organic nature only	Cells
connect the organisational levels of the organic world with the characteristics of life and describe the fields and professions of biology studying these levels of organisation;	
give reasons for the necessity of using scientific methods in solving scientific and everyday problems	
plan and carry out inquiry-based experimentation	
analyse texts about problems associated with applying scientific methods, giving reasoned opinions about these texts	
using scientific methods arrive at sound conclusions	
compare the chemical compositions of organic and inorganic matter in nature	Composition of organisms
associate the properties of water with the functioning of organisms	
explain the importance of cations and anions in the structure and functioning of organisms	
associate the structure of carbohydrates, lipids and proteins with their functions	
compare the structure and functions of DNA and RNA;	
appreciate the role of water, minerals and biomolecules in healthy nutrition	
describe the main techniques for performing a microscopic examination	Cell diversity
analyse the roles of plastids, vacuoles and the cell membrane in the life of plants	
compare the structure of animal, plant and fungal cells and identify these cells on slides, microscope images and drawings	
compare bacterial cells with eukaryotic cells;	
identify bacterial, fungal, plant and animal cells on microscope images and drawings	

by giving examples, identify the use of fungi and bacteria in applied fields of biology	
associate the most common human fungal infections with the preventive measures used against them and value healthy lifestyles	
describe the significant role of fungi and bacteria in nature and appreciate them as an important part of the organic world.	
1) analyse the energy needs and energy-producing methods used by autotrophic and heterotrophic organisms	Energy needs of organisms
explain the universality of ATP in energy storage and transfers	
explain the role of environmental factors during the stages of respiration and in energy storage	
by giving examples, indicate the value of fermentation from applied biology	
compare the cost/benefit ratio of aerobic and anaerobic respiration in human muscle	
analyse the tasks, results and importance of photosynthesis	
compile and analyse sketch drawings and definition cards describing the relationships between photosynthesis and the biosphere	
describe the value of photosynthesis for plants, other organisms and the biosphere as a whole.	
associate the parts of the human nervous system with their functions	Regulatory mechanisms in humans
analyse the role of different factors on the formation of neural signals and their transmission	
associate the most common disabilities and diseases of the nervous system with their manifestations	
value the showing of a negative attitude towards the use of substances damaging the nervous system;	
explain the importance of protective mechanisms and the immune system in the human body	
compile and analyse sketch drawings and definition cards describing the role of neural and humoral regulations in coordinating the functioning of the human body	
explain the mechanisms of guaranteeing stable blood composition and its importance	
describe the thermoregulatory mechanisms in the human body and the relationships between these mechanisms	

evaluate the role of genetic and environmental factors in the development of individual characteristics	Principles of molecular biology
analyse the role of DNA, RNA and proteins in the expression of genetic information	
compare the processes and product of DNA and RNA synthesis	
evaluate the role of genetic regulation in different stages of human ontogenesis and appreciate the influence of the environment on genetic regulatory mechanisms	
compile an experiment to prove the universality of the principles of molecular biology	
undertake a search to find examples of human diseases associated with gene regulation disorders	
explain the properties of genetic code and its expression during protein synthesis	
explain the synthesis of proteins.	
explain the evolutionary views of Darwin;	Biological evolution
by giving examples of scientific research, present evidence of biological evolution;	
analyse and evaluate theories on the origins of life on Earth; 4)	
compare types of natural selection, the conditions of their occurrence and their products	
analyse and evaluate the roles of different factors in the emergence of new species	
analyse the origins and manifestations of evolutionary diversification, improvement and extinction;	
evaluate the roles of biological and social factors in the evolution of modern man	
illustrate, through justified actions, how a critical attitude towards pseudo-scientific discourse on biological evolution is possible	
analyse the role of human activities in species extinction and demonstrate responsibility in their activities in the natural environment	Environmental protection
explain the importance of the protection of biological diversity	
value biological diversity and acknowledge the responsibility of every human being in its protection;	
identify the mutual relationships between nature, technology and society and give reasons for	

sustainable development at the personal, local, national and international levels	
explain the groups of protected natural objects listed in the Nature Protection Act of Estonia and give examples	
appreciate the protection of nature and the environment as a cultural phenomenon	
use local examples to solve environmental dilemmas considering scientific, economic and ethical perspectives as well as legislation	
subject basic trends in nature and environmental protection to critical analysis and determine a justified position.	

9.2.3.3 Geography

Topics	Subject
Students learn to: relate the history of geography to the current situation, discuss connections between geography and other sciences and recognise the position of geography in the sphere of modern science	Population and Economy
by giving examples of modern methods used in geography, carry out observations and surveys, use questionnaires and employ databases to obtain the necessary information;	
find, evaluate and use sources of information (including maps) to obtain information, analyse correlations and make generalisations and conclusions	
analyse natural conditions and the populations, economies and possible consequences of human activities in a given area using various sources of information, including maps.	
characterise, with justification, the Earth as a system and give examples of relationships between them	System Earth
analyse the relations between natural environment the natural environment and human activities	
describe the general evolution of Earth on the basis of the geological time scale.	
1) evaluate of the composition of the atmosphere and the structure of the atmosphere with the help of figures	The Atmosphere
explain the Earth's radiation balance and the Greenhouse Effect;	

explain how climate is shaped by different factors, including the development of seasons;	
explain air circulation and its effect on a specific, local climate	
analyse the effect of the climate on other components of nature and on human activities	
justifiably forecast the climate of a given location using weather maps	
analyse the climate of a given location using maps on topic and climate charts and associate it with the factors shaping the climate; and 8)	
analyse, on the basis of figures, the short and long term changes in climate and explain the role of different factors, including astronomical, in climate change.	
explain the reasons behind food problems in different parts of the world	Natural resources and management
characterise self-consumption and commercial, and intensive and extensive agriculture on the example of different farm types	
analyse agriculture in countries with different natural circumstances and levels of development on the basis of sources of information	
have an overview of the main regions of cultivation of the most important crops	
explain the impact of agriculture to soil and groundwater	
bring examples about environmental problems caused by agriculture and aquaculture in developed and less developed countries.	
analyse the causes of energy problems and possible solutions to them and appreciate sustainable uses of energy	Energy and environmental programmes
explain the political, economic and environmental problems accompanying the use of energy resources	
use evaluated information to analyse changes in world energy use	
analyse the use of fossil fuels for producing energy and the involved environmental problems, know the main mining/extraction regions	
analyse the socioeconomic and environmental problems involved in building a hydroelectric power stations on one example	
analyse the risks related to producing nuclear power on the example of specific examples	

analyse the possibilities for the use of renewable energy sources, as well as the problems accompanying them;	
use evaluated sources of information to analyse energy resources and their uses.	

9.2.3.4 Chemistry

Topics	Subject
Students learn to: describe the placement of electrons in the outer electron layer of an atom (single electrons, electron pairs) depending on the placement of the element in the periodic table (in case of elements from group A);	Fundamentals of chemistry
explain changes in the properties of metals and non-metals in the periodic table (group A) in relation to the changes in the atomic structure;	
determine the maximum and minimum oxidation levels of group A chemical elements according to the placement of the element in the periodic table and write the formulas for the model compounds of these elements	
on the basis of model examples, explain the nature of a covalent, ionic, metallic and hydrogen bond	
evaluate the polarity of a covalent bond on the basis of the placement of the elements forming the bond in the periodic table;	
describe and evaluate the effect of the mutual impact of chemical bonds and molecules (also hydrogen bond) to the properties of substances	
associate a chemical reaction with particles crossing over to a more permanent state	Why and how chemical reactions occur
explain the thermal effects of chemical reactions on the basis of changes in energy occurring when chemical bonds are formed or disintegrated	
analyse the effects of factors affecting the speed of a chemical reactions and explain the changes in the speed of chemical processes in everyday life	
understand that in case of reversible reaction, there will be an equilibrium	
describe the creation of solutions (in case of ionic and covalent substances)	Dissolution process
differentiate between electrolytes and non-electrolytes and strong and weak electrolytes	

explain the concepts of acid and base on the basis of proteolytical theory	
calculate molecular concentration	
create formula for interionic reactions (in molecular and ionic form);	
evaluate and justify the environment created in the solution by dissolving different substances in water	
associate the chemical properties of studied metals with the position of the element in the periodic table and their position in the period and compile corresponding reaction equations (metal reacting with a non-metal, water, diluted acid and salt solution)	Inorganic substances
describe the possible practical applications of the studied metals and their alloys;	
know the most common natural metal compounds and their applications	
explain the principle of producing metals by reducing metal compounds and corrosion in the oxidation of metals;	
explain the reversed energetic effect of corrosion and metal production, analyse the options for preventing corrosion	
analyse the general principles of redox processes (e.g. electrolysation, corrosion and in case of a chemical source of electrical current)	
solve calculus tasks according to reaction equations, considering the yield and additions	
associate the chemical properties of most common non-metals and their model compounds with the placement of the element in the periodic table	Non-metals
write equations of characteristic reactions of the studied non-metals and their compounds.	
describe the importance of the studied non-metals and their compounds in nature and/or the possibilities for applying them in practice	
use different methods of depicting molecules (simplest structural formula, two-dimensional i.e. classical structural formula, graphic representation of molecules)	Hydrocarbons and their derivatives
use the principles of systematic nomenclature on the example of alkanes; associate the prefixes or suffixes of systematic names with the studied chemical classes, determine the chemical class of based on the molecular structure or name	
evaluate the physical properties (solubility in different solvents and boiling temperature) on the	

basis of the molecular structure (capacity to form hydrogen bonds)	
compare the chemical properties of saturated, unsaturated and aromatic hydrocarbons, write simpler reaction equations about the halogenation reactions of alkanes, alkenes and arenes an hydrogenation and catalytic hydration of alkenes (without reaction mechanisms)	
describe the properties of more important hydrocarbons and their derivates, their applications in everyday life and dangers related to their use	
depict a section of a polymer produced from an alkene.	
determine the chemical class of a substance on the basis of the molecular structure	Organic substances around us
describe the properties of more important carboxyl acids and their importance in everyday life and nature	
explain the relationship between alcohols, aldehydes and carboxyl acids	
compare the chemical properties of carboxyl acids and inorganic acids and compile corresponding reaction equations	
describe the chemical processes in the body accompanying alcohol intoxication and the social problems associated with it	
compare the formation and hydrolysis reactions of esters and compile corresponding equations	
depict a section of a condensation polymer derived from source compounds	
explain in principle the structure of biomolecules (polysaccharides, proteins and fats).	

9.2.3.5 Physics

Topics	Subject
Students learn to: explain the meaning of terms nature, world and observer, evaluate the position of physics among other natural sciences and define the field of study of physics	Kinematics or Translation of motion
recognise the micro, macro and mega worlds on the scheme of structural levels of nature and name the differences between these levels	
explain the nature of natural science method and know that generalising the results of an experiment leads to a model	

explain the need for rules of measurement for obtaining generally accepted measurement results	
understand the difference between a measuring unit and the measured quantities	
know and implement the main units of the International System of Units (SI) and their measurement units	
know that a correct measurement result also includes uncertainty and use the standard deviation when evaluating the measurement uncertainty in measuring	
bring examples of causal associations	
understand that the general principles of physics are the most general acknowledgements about nature and prove their validity with a confirmation experiment.	
understand that the physical quantities length (also distance), time interval (Δt) and time (t) are based on comparison of objects and their mutual motion (processes)	
know that the state of motion of an body is characterised by velocity and give examples of the relativity of motion in the macro world;	
know the main difference between relative physics and classical physics	
know that a field is always moving with the highest possible velocity, i.e. absolute velocity with regard to matter	
differentiate between scalar and vector quantities and give examples of them	
explain the meaning of the minus sign in physics formulas (the direction changing to the opposite of the original direction)	
differentiate between the important characteristics of phenomena such as even linear motion, evenly accelerating liner motion, evenly decelerating linear motion and free falling and bring appropriate examples	
explain the meanings of physical quantities such as velocity, acceleration, distance and displacement and identify the methods of measuring and finding these quantities	
solve problem tasks applying the definitions and ; describe constant liner motion and uniformly changing motion by respective motion formulas or 35	
analyse the charts of velocity and distance of constant and uniformly changing linear motion;	

be able to find the distance as the surface area in the velocity chart	
implement the following associations for finding the velocity, displacement and acceleration of uniformly changing linear motion, including free falling: ; ; .	
explain the occurrence of phenomena interaction, gravitation, friction and deformation and their application in nature;	Mechanics
supplement a given figure with vectors showing the forces affecting a body both when the state of motion is constant (v = const, a = 0) or changing (a = const ≠ 0);	
able to find the net force trough force components	
explain and apply Newton's laws and associate them with everyday phenomena	
formulate the law of conservation of momentum and solve problem tasks using the relationship	
associate reactive motion with the law of conservation of momentum, give examples of reactive motion in nature and its implications in technology	
give examples about phenomena where the velocity of the momentum changing is equal with the force causing the change	
apply the Law of Gravitation	
know the definition of field of gravity	
know that general theory of relativity describes the gravitational interaction through bending space-time;	
use terms gravitation, weight of body, reaction of supports, stress and pressure when solving problem tasks and applies the relation P = m (g ± a)	
use terms gravitation, weight of body, reaction of supports, stress and pressure when solving problem tasks and applies the relation P = m (g ± a)	
explain terms friction force and elastic force and when explaining phenomena occurring in natural and artificial environments, applies the relations Fh = μ N and Fe = – k Δl	
apply terms work, energy, kinetic and potential energy, power, output energy, energy conversion efficiency when explaining phenomena in nature and artificial environments	
solve problems by applying relationships A = Fs cos α; , Ep = mgh and E = Ek + Ep; 15) explain	

the validity of the principle of minimum energy in nature and artificial environments.	
explain terms charge, current and amperage and the meaning of the formula ; 2) 3) associate the electrostatic field with the existence of a charged body by applying the formula ; 4)	Electric and magnetic fields[21]
compare terms matter and field;	
associate the electrostatic field with the existence of a charged body by applying the formula	
use Coulomb's law for solving problems	
use relations , , and ; for solving problems	
use the principle of superposition for constructing the E-vector of an electrostatic field at a given point	
know that a homogenous electric field is created between two parallel charge-carrying plates with different charges	
know that there are two principally different causes for magnetic fields: permanent magnets and current-carrying wires) and apply the formula	
apply Ampere's law for solving problems;	
determine the direction of magnetic induction created by a straight wire in a given point;;	
use the formula F = B I l sin α and Ampere's rules for determining the direction of a force;	
apply the Lorentz force formula FL = q v B sin α for solving problems and determine the direction of Lorentz force	
explain the creation of a electrodynamic field upon changes in the magnetic flux by applying the definition of the electromotive force of induction;	
compare the work principles of a generator and an electric motor;	
explain the term electromagnetic wave and the applications of electromagnetic waves	Electromagnetic waves
describe the oscillatory circuit as the basic equipment for radiating and absorbing electromagnetic wave	
describe the electromagnetic spectrum by applying the relation c = f λ, and know the bordering values of visible lights and the order of the wavelengths of the spectral colours; 4)	

[21] https://www.hm.ee/sites/default/files/est_upper_secondary_nat_cur_2014_appendix_4_final.pdf p.38

explain wave amplitude and intensity of electromagnetic waves according to a chart	
describe the phenomena of interference and diffraction in optics using figures or computer imitation and bring examples of their applications;	
explain the circumstances of light coherence and the need for their completion to obtain a specific interference picture	
associate the characteristics of polarised light with applications in nature and technology	
apply the law of refraction of light using correlations and	
describe the options for separating white light into a spectrum	
compare main types of spectrums;	
explain the emergence of light on the scheme of energetic levels of an atom and apply the formula E = h f for solving problems;	
explains the principle of duality of light and is relation to the atomistic principle;	
distinguish between thermal radiation and luminescence and associate them with corresponding sources of light.	
explain the creation of electric current on the micro level, applying the correlation I = q n v S	Energy
apply Ohm's law for a part of the circuit and the whole circuit: , in solving problems	
apply the following equations for the work and power of electric current: , in solving problems	
analyse the graph of temperature dependence of resistance of metals	
describe the intrinsic and extrinsic conductivity of a semiconductor, including electron conductivity and hole conductivity	
explain the nature of p-n transfer, including in case of forward bias and reverse bias, and associate it with the functioning of a light diode and photo element	
compare alternating and direct current;	
analyse the chart of the dependence of the voltage and amperage of alternating current from time	
calculate the power of alternating current in the case of an active appliance, applying the relationship	

explain the operating principle of a transformer and its applications in an alternating current main and transferring electric energy	
calculate the cost of used electrical energy and plan the implementation of new electrical devices on that basis	
the requirements of electrical safety and justify the need for them.	

9.2.4 Germany

Subjects of interest are Biology, Chemistry, Physics, Geography, and Mathematics

9.2.4.1 Mathematics

Topics	Subject
Students learn to: Order and compare rational numbers	Arithmetic and Algebra—Dealing with numerals and symbols
Execute basic arithmetic operations for rational numbers (mental arithmetic and written arithmetic techniques)	
Aggregate terms, multiply them, and factor them using simple factors	
Solve linear equations by trial and error, as well as algebraically, and check calculations by applying the solution	
Apply knowledge of rational numbers and simple linear equations to solving mathematical and extra-mathematical problems	
Give non-mathematical reasons and examples for the extension of the set of natural numbers to the set of rational numbers	
Express relationships in words, in tables of values, in graphs, and in mathematical symbols, and shift among different forms of representation	Functions—Describing and investigating relationships and changes
Interpret linear functions in terms of equations and graphs	
Identify proportional, nonproportional, and linear relations in charts, mathematical symbols, and real world situations	
Apply the characteristics of proportional, no proportional, and linear relations, as well as simple procedures of the Rule of Three for the solution of mathematical and nonmathematical problems	
Compute percentages and base values in real world situations	

Name and characterize triangles (right, isosceles, and equilateral), parallelograms, rhombuses, trapezoids, and simple prisms, and identify them in real-world situations	Arithmetic and Algebra—Dealing with numerals and symbols
Draw triangles from given measures of angles and sides	
Sketch angular illustrations, create nets of cubes and cuboids, and construct geometrical objects	
Estimate and define the perimeter and surface area of triangles, parallelograms, and figures constituted by these shapes	
Specify surface areas and volumes of cubes, cuboids, and simple prisms	
Discern and justify attributes of figures by means of symmetry, theorems of angles, or congruence	
Plan the collection of data, conduct surveys, and use spreadsheets for data organization	Stochastic Processes—Working with data and chance
Use median, range, and quartiles for the description of frequency distributions	
Use simple experiments of chance to describe stochastic events in everyday situations	
Use relative frequencies from repeated experiments to estimate probability	
Use the Rule of Laplace to ascertain probabilities in simple experiments of chance	
Use probability to evaluate chance and risk and to estimate	
frequency	
Interpret ranges and quartiles in statistical illustrations or descriptions	

9.2.4.2 Physics

Topics	Subject
	Forces
	Energy and power
	Machines
	The Electric motor

9.2.4.3 Chemistry

Topics	Subject
	Families of elements
	The periodic table
	Atomic structure

9.2.4.4 Biology

Topics	Subject
	Properties of ecosystems
	Energy transfer in ecosystems
	Changes in ecosystems

9.2.4.5 Earth science

Topics	Subject
	Natural hazards to living environments
	Anthropogenic hazards to living environments

9.2.5 Greece

Subjects of interest are Biology, Geography Chemistry, Informatics, Physics, Mathematics

9.2.5.1 Biology

Topics	Subject
Microorganisms	Humans and health
Immunity system	
Cancer	
Addictions	
Ecosystems	Humans and environment
Energy flow	
Biochecmical cycles	
Theory of evolution	Evolution
Taxonomy	
Human evolution	

9.2.5.2 Geography

Topics	Subject
Reading maps	Maps
Working with scales	
Use of maps in everyday life	
Biosphere	Natural environment
Earth movement	
Climate change	
Natural resources	Cities, population, resources and human activities

Energy resources	
Renewable energy	
Geographical and financial characteristics of the difference continents	Continents
Morphology of Europe	Europe
Natural environment of Europe	
European inhabitants and their activities	

9.2.5.3 Mathematics

Topics	Subject
Natural numbers	Algebra
Equations	
Inequalities	
Functions	
Linear systems	
Trigonometry	
Introduction to Euclidian geometry	Geometry
Shapes and their properties	
Triangles and their properties	
Lines	
Parallelograms, Trapeziums	
Analogies	
Symmetries	
Pythagorean theorem	
Calculating area and volume	
	Calculus
	Statistics
	Probabilities

9.2.5.4 Informatics

Topics	Subject
Basic concepts	Getting to know the PC
History of Information technologies	
Introduction to the existing basic software	Basic software
Security issues and viruses	
Painting	Use of creative tools, editing and communication tools

Document editing	
Creating pgraphs and presentations	
Uses of WWW	Introduction to the WWW
Looking for information in the WWW	
Use of electronic mail (email)	
Use of computers in our daily lives	The use of computers in our daily life
	New technologies and new related professions

9.2.5.5 Physics

Topics	Subject
	Linear movement
	Gravity
	Mechanics
	Momentum
	Preservation of energy
	Oscillations
	Theory of relativity
	Introduction to quantum mechanics

9.2.5.6 Chemistry

Topics	Subject
	Molecule structure
	Periodical table
	Acids
	Solutions
	Catalysts

9.2.6 Portugal[22]

Subjects of interest are Mathematics, Physics, and Chemistry

9.2.6.1 Mathematics

Topics	Subject
Students learn to: Further develop and understand the notion of integers and rational numbers and their properties and operations	Numbers and operations

22 http://timss2015.org/encyclopedia/countries/portugal/the-science-curriculum-in-primary-and-lower-secondary-grades/

Powers, quadratics, and cubic roots	
Notion of real numbers and their rational and nonrational parts, their representation on the real number line; understand and do more complicated operations in the domain of	
Further develop and understand the notion of integers and rational numbers and their properties and operations	
Powers, quadratics, and cubic roots	
Notion of real numbers and their rational and nonrational parts, their representation on the real number line; understand and do more complicated operations in the domain of	
Further develop and understand the notion of integers and rational numbers and their properties and operations	
Understand, classify, and do operations with triangles and quadrilaterals; understand their properties and properties of angles; geometric solids areas and volumes; parallel and perpendicular lines; and planes, circumferences, and angles	Geometry
Understand and construct geometric planes, circles, circumferences, bisectors, spherical surfaces, and mediator planes	
Construct inscribed and circumscribed circles and polygons	
Identify and construct congruent and similar figures	
Recognize and use vectors in geometric transformations (translation, reflection, and rotation)	
Demonstrate and use the Pythagorean theorem	
Develop algebraic reasoning and language and solve problems involving algebraic procedures using sequences and patterns	Algebra
Understand and solve first-degree equations with one unknown, literal equations, and polynomials; understand and solve second-degree equations with one unknown and two equations systems with two unknowns; and understand and solve first-order inequalities	
Further develop the use of statistical data analysis to make informed decisions	Organisation and data processing
Develop skills for statistical planning, formulate questions and plan adequate data collection	
Further emphasis on the organization, analysis, and interpretation of data, construct and interpret graphical data representations, and understand	

the concepts and estimate measures of central tendency and dispersion	
Choose the appropriate statistics for different data types, compare data distributions, and discuss critically inferences to populations from the analysis of samples	
Understand the notion of random events and random experiments, and understand and do probability calculations using relative frequencies and the Laplace rule	

9.2.6.2 Sciences

In the third cycle of Basic Education (Grades 7 to 9), science is taught as Natural Sciences plus Physics and Chemistry. Natural Sciences in Grade 7 focuses on Earth in transformation. Students are introduced to external and internal Earth dynamics, consequences of internal Earth dynamics, Earth's geological history, and the sustainability of life on Earth. In Grade 8, students are introduced to the Earth system, from cells to ecosystems, and to the sustainable management of Earth's resources. Finally, Grade 9 focuses on better living on the planet. The curriculum details individual and community health with emphasis on the human body equilibrium, its structure, composition, organ functioning, and basic life support, as well as human reproduction and genetics.

The Physics and Chemistry Sciences course in Grade 7 focuses on:

- Space—The universe, the solar system, distances in the universe, Earth, the moon, and gravitational forces
- Materials—Substances and mixtures, physical and chemical transformations, physical and chemical properties of materials, and separation of substances in a mixture
- Energy sources and energy transfer

The Grade 8 curriculum further builds on the themes from the previous grades with emphasis on:

- Chemical reactions—Representation and understanding of chemical reactions, types, and reaction rates
- Sound—Production and propagation, sound as waves, sound attributes and their detection by humans, and acoustic phenomena
- Light—Light waves, their propagation, and optical phenomena

Finally, in Grade 9, the subjects taught include:

- Movement and forces—Movement on Earth, forces, movement and energy, and liquids
- Electricity—Electric currents, and energy and its effects
- Materials classification—Atomic structures, properties of elements of the Periodic Table, and chemical bonding

9.2.7 Finland

Subjects of interest are Mathematics, Geography, Physics, Chemistry, Health education

9.2.7.1 Mathematics

Topics	Subject
Students learn about:	Thinking skills and methods

processes that demand logical thinking, such as classification, comparison, organization, measurement, constructing, modelling, and articulating rules and correlations; the interpretation and use of concepts to make comparisons and correlations; the interpretation and production of mathematical texts; introduction to proof, including justified conjectures and experiments, systematic trial-and-error method, demonstrating incorrectness, and direct proof; solving combinatorial problems; use of tools and drawings to investigate problems; and the history of mathematics	
strengthening basic calculation skills; natural numbers, whole numbers, rational numbers, and real numbers; negative numbers, absolute values, and reciprocals; time calculations and intervals; prime numbers, division of numbers into prime factors, and rules for divisibility; reduction of fractions, conversion of fractions and decimal fractions as common fractions; multiplication and division with fractions and decimal fractions; simplification of expressions; ratio and proportion; strengthening the concept of percentage and calculating percentages; rounding and estimation; using a calculator; powers using whole number exponents; and the concept of root and square root calculations	Numbers and calculations
expressions and their simplification, exponential expressions and their simplification, and the concept of polynomials; addition, subtraction, and multiplication of polynomials; concept of variables; calculating the value of an expression; equation, inequality, domain, and range; solving a first-degree equation and an incomplete quadratic equation; proportionality; simultaneous equations and their solution algebraically and graphically, and study and formulation of number sequences	Algebra
observing correlation and presentation by means of variables; concept of the function; presenting a set of coordinates in a coordinate system; interpreting simple functions and drawing their graphs in a coordinate system; investigating the graph of a function, including the function's root, largest and smallest values, increasing and decreasing functions; linear functions; and direct and inverse proportionality	Functions
relationships between angles; concepts related to triangles and quadrilaterals; regular polygons; the circle and related concepts; calculating the perimeter and area of plane figures; naming and classifying three-dimensional figures; calculating the volume and surface area of a three-dimensional figure; similarity and congruence; geometric constructions; depictions of congruence, including reflections, rotation, and transformation; the Pythagorean theorem; relationships between triangles and circles; and trigonometry and solving right triangles	Geometry
concept of probability; frequency and relative frequency; determining average, mode, and	Probability and statistics

median; concept of dispersion; interpretation of graphs; and gathering and adapting information, and presentation in a usable form	

9.2.7.2 Sciences

Topics	Subject
identification of major species of plants, fungi, and animals in students' home regions, and guided collection of plants; the ecosystem and its structure and operation, distinctive features of forest and aquatic ecosystems, and independent research on one ecosystem; introduction to forestry, crop husbandry, and biodiversity	Nature and ecosystems
structure and activity of the cell; emergence, development, and organization of the population; biological and cultural evolution of human beings, and distinctive features of the human species; and potentials of biotechnology, including related ethical questions	Life and evolution
structure and major vital functions of the human body; human sexuality and reproduction; and importance of genotype and the environment in the development of human characteristics	The human being
ecologically sustainable development and objectives of environmental protection; and investigation of the conditions of, and changes in, one's living environment, examination of measures to improve the condition of one's immediate environment, and consideration of ways to improve one's environmental behavior	The common environment

9.2.7.3 Geography

Topics	Subject
humanity's home planet, including identifying the physical geographic and human geographic map views of the world and analyzing the world regionally; major internal and external events of Earth; and the continents, including comparison of natural conditions, human activity, and cultural features	Earth – Humanity's home planet
basic features of Europe's geography, natural conditions, landscape, and human activity; interaction of those features in different regions of Europe; and geographic study of Europe as a part of the world and the future of Europe	Europe
Finland's geography and landscape; interaction of nature and human activity in different regions of Finland, the manmade environment and traditional landscapes; population of Finland and its minority cultures; opportunities for influence in planning and developing one's environment; Finland as a part of the world; and small scale research into one's immediate environment or home municipality, including natural, manmade, and social environments	Finland in the world

environmental and developmental questions, locally and globally; consideration of possible solutions to problems; environmental questions in the Baltic region; and human beings as consumers of natural resources	The common environment

9.2.7.4 Physics

Topics	Subject
Interactions and the corresponding forces, including the phenomena of motion and equilibrium that arise from those interactions and occurrence of those phenomena in nature; motion and models of uniform and uniformly accelerating motion; work done by a force; and mechanical energy and power	Motions and force
Various basic phenomena of vibrations and wave motion; production, detection, observation, and reflection and refraction of wave motion; related properties, quantities, and laws of waves; importance and applications of sound and light; and functioning principles of optical instruments	Vibrations and wave motion
Phenomena associated with heating and cooling of objects and substances; description of those phenomena with appropriate concepts and laws; importance and applications of thermal phenomena; and conservation and degradation of energy, and heat as a form of energy	Heat
Electrical and magnetic forces between objects; direct current circuits; basic phenomena of electrical circuits; safe application of those phenomena in everyday life and technology; electromagnetic induction and its use in energy transmission; and use of electricity at home	Electricity
Natural structures and proportions; interactions that keep structural components together; binding and release of energy in processes occurring between components; radioactive decay; fission and fusion; ionizing radiation and its effect on animate nature; and protection from radiation	Natural structures

9.2.7.5 Chemistry

Topics	Subject
Atmospheric substances and their importance to the individual and the equilibrium of nature; water and its properties, such as acidity and alkalinity; flammability of substances; combustion reaction and its description using the symbolic language of chemistry; and properties of the products of combustion and their effects on the environment	Air and water
Key elements and compounds found in Earth's crust and their properties, and the manufacture, use, efficiency, and recyclability of products; electrochemical phenomena, the electrochemical cell and electrolysis, and their applications; symbolic designation, classification, and distinction of elements and compounds;	Raw materials and products

comparison of reaction rates; interpretation of reaction equations and balancing of simple reaction equations; and explanation of properties and structures of elements and compounds with the aid of an atomic model or the periodic table	
Photosynthesis and combustion; energy sources; oxidation reactions and reaction products of organic compounds such as alcohols and carboxylic acids, and properties and uses of these products; hydrocarbons, proteins, and lipids, and their composition and importance as nutritional substances and industrial raw materials; detergents and cosmetic materials; and textiles	Living nature and society

9.2.7.6 Health education

Topics	Subject
Birth, death, and the different stages of life; physical growth and development, including daily rhythm, sleep, rest and stress, health-enhancing physical activity, and nutrition and health; psychological growth and development, including self-knowledge and self-esteem; family and social relationships; mental health and its changes, and the balance of mind and body; social growth and development, including individuality and diversity, individual obligations and responsibilities within the community, tolerance, and caring; needs and special features in the development of young people and development of sexuality; and taking care of one's health	Growth and development
Nutritional needs and problems in different situations; common allergies and special diets; smoking, alcohol, drug abuse, and the use of other intoxicating substances; pleasure, dependency, and making choices; solving conflicts and talking about issues; sexual health, including human relations, sexuality, behaviour, and related values and norms; common infectious diseases and illnesses, recognition of symptoms, being ill, and self-care; and traffic safety and behaviour in traffic, dangerous situations, and accidents and first aid	Healthy choices in daily living
Health, work skills, and functional abilities as personal resources; emotions and their expression, social support and safety nets, and interaction skills; changes related to development and life span; and crises and coping with them	Resources and coping skills
National diseases; environment and health, on-the-job welfare, culture, and health; main healthcare and welfare services, careers in nongovernmental organizations; and rights of children and young people and legislation regarding limitations on activities and consequences	Health, society and culture

9.2.8 France

Subjects of interest are Mathematics, Physics, Chemistry, Life and earth sciences

9.2.8.1 Mathematics

Topics	Subject
Students learn to: use the principles of decimal place value	Functions
reading and write numbers in figures and in words	
to compare and order numbers, locating numbers on a graduated line, and using the signs > and <	
use arithmetic relationships between commonly used numbers (e.g., double, half, quadruple, quarter, triple, and third) and the concept of multiples	
perform simple and decimal fractions—Writing fractions, locating fractions between two consecutive integers, writing fractions as the sum of an integer and a fraction less than 1, and calculating the sum of two decimal fractions or the sum of two fractions with the same denominator	
use decimal numbers—Reading and writing decimals, determining decimal place value, converting between decimals and fractions, comparing, ordering, and locating decimals on a number line, and rounding decimals to the nearest whole number, the nearest 10^{th}, and the nearest 100^{th}	
perform mental—Learning addition and multiplication tables; daily exercises in mental calculation using the four operations help students develop number sense	
master of an arithmetic technique for each of the four operations is essential	
use calculators depending on the computational complexity of the problems they are solving	
geometric relationships and geometric properties—Alignment, perpendicularity, parallelism, equality of lengths, axial symmetry, middle of a segment	Geometry
about the use of instruments and techniques—Ruler, square, compass, tracing paper, graph paper, dotted paper, and folding paper	
work with plane figures—Squares, rectangles, diamonds, parallelograms, triangles, special triangles, and circles	
describe, reproduce, and construct plane figures	
use the vocabulary specific to plane figures (e.g., side, top, angle, diagonal, axis of symmetry, centre, radius, and diameter)	
enlarge and reduce plane figures, linked with proportionality	
regular solids (i.e., cubes, rectangular parallelepipeds, cylinders, prisms, and pyramids)	
recognize regular solids and studying certain patterns	

use the vocabulary specific to regular solids (e.g., vertex, edge, and face)	
reproduce and construct various geometric configurations requires students to apply their knowledge of regular figures and gives students the opportunity to use specific vocabulary and approaches to measuring and drawing	
use length, mass, and volume—Measurement, estimation, legal units of the metric system, calculation of quantities, converting between units of measurement, perimeter of a polygon, formulas for the perimeter of a square and of a rectangle, circumference of a circle, volume of a rectangular parallelepiped	Quantities and measures
area—Comparing surfaces according to their area, regular units, conversions; formulas for area of a rectangle and of a triangle	
use angles—compare angles, using templates and set squares; acute, obtuse, and right angles	
use time—read clocks and calendars	
duration—Units of measurement of duration, calculating time elapsed between two given moments	
solve concrete problems using money	
organization and manage data skills by solving problems in everyday life or in other subject domains; students gradually learn to sort data, to classify data, and to read, produce, and analyze tables and graphs	organisation and management of data
work in contexts involving percent, scale, unit conversion, and enlargement or reduction of figures, and using several different procedures (especially the rule of three)	

9.2.8.2 Physics- Chemistry

Topics	Subject
	health
	sport practice
	universe

9.2.8.3 Life and earth sciences

Topics	Subject
	The earth and the universe, life and the evolution of life
	contemporary planetary issues
	the human body and health

9.2.9 Spain[23]

Subjects of interest are Mathematics, Physics, Chemistry, Natural science

9.2.9.1 Mathematics

Topics	Subject
By the end of Grade 8, students will have studied cross-curricular content in all areas, such as problem solving strategies, and attitudes such as persevering in the search for solutions and assessing completed work; and use of technological tools (e.g., calculators and computers) to facilitate calculations, representations, and geometric properties.	Common content
By the end of Grade 8, students will have studied problem-solving strategies, and they should have become familiar with the analysis of problem statements, trial and error, splitting problems into parts, and testing obtained solutions.	
By the end of Grade 8, students will have studied numeracy concepts that began at the primary level extended to include all real numbers (e.g., integers, rational numbers, and irrational numbers) and new operations such as exponents (e.g., powers and roots) and logarithms; understanding of operations and practice using estimation skills and mental computation to control for possible errors in results; and numerical proportion.	Numbers
By the end of Grade 8, students will have studied whole numbers, fractions and decimals, how to calculate percentages, increasing and decreasing powers of natural exponents and their operations, and scientific notation. Students also will have covered the use of the sexagesimal system for measuring time and angles. Their study of proportionality will have extended to inverse proportions.	
By the end of Grade 8, students will have studied yhe use of algebraic language (e.g., polynomials and equations).	Algebra
By the end of Grade 8, students will have learned about first-degree binomials and should know how to solve linear equations and use linear equations to solve problems.	
By the end of Grade 8, students will have studied calculation of surface area and volume; description of geometric figures; and analysis, classification, and relationships between elements of geometric figures.	Geometry
By the end of Grade 8, in plane geometry students will have studied the Pythagorean theorem, similarity (e.g., similarity ratio and scales), and Thales' theorem. In solid geometry, students will have studied the basic elements: points, lines and planes, the relationships between them (e.g.,	

[23] http://timss2015.org/encyclopedia/countries/spain/

incidence, parallelism, and perpendicularity between straight lines and planes), geometric figures, and the calculation of surface areas and volumes.	
By the end of Grade 8, students will have studied different types of functions (e.g., constant, linear and related, quadratic, exponential, and logarithmic) and their characteristics, with an emphasis on graphs (e.g., points of intersection with the axis, growth and decay, continuity, and symmetry).	Functions and graphs
By the end of Grade 8, students will have studied the characteristics of a function and its graph, as well as linear and inverse proportionality functions. Students also will have begun to use a graphing calculator and computer applications for drawing function graphs.	
Statistics topics—By the end of Grade 8, students will have studied basic concepts such as population, sample, discrete and continuous variable, organization of data in frequency tables and statistical graphs, and calculation of central tendency and dispersion measures to prepare students for critical analysis of statistical information.	Statistics and probability
Probability topics—By the end of Grade 8, students will have studied simple and compound probability, including randomized experiments, the assignment of probabilities by Laplace's law, contingency tables, and tree diagrams. In Grade 10, Mathematics B topics also include combinatorics, applications to the calculation of probability, and conditional probability.	
Skills—By the end of Grade 8, students will have studied various elements of statistics: absolute, relative, and cumulative frequency tables; statistical diagrams, including pictograms, population pyramids, and climate diagrams; and calculation of the mean, median, and mode. Students also should have learned how to use spreadsheets to organize data, perform calculations, and create graphs.	

9.2.9.2 Natural science

Topics	Subject
Interpret natural phenomena (e.g., day and night, time and seasons, eclipses, and tides) using models of the solar system and the movements of the Moon, Earth, and the Sun	Natural phenomena
Describe the observations that make it possible to understand the universe (e.g., sphericity,	

movements of Earth, heliocentric and geocentric systems)	
Interpret the properties of matter (e.g., mass, volume) and the procedures used to investigate them	
Relate the properties of materials to their common uses, differentiate between compounds and mixtures, and apply separation techniques	
Know the properties of air and the atmosphere, recognize the impact of human activity on them, and interpret weather phenomena	
Explain the properties of water, the water cycle, the importance of water for life, and the impact of human activity on water resources	
Identify the most common rocks and minerals and their applications	
Recognize the cellular constitution of living things and their vital functions	
Classify living things into major taxonomic groups	
Use the concept of energy to explain changes, and recognize renewable and nonrenewable energy sources in addition to their advantages and disadvantages	Energy
Differentiate between heat and temperature and understand how they are measured, solve problems by applying concepts of thermal equilibrium, and recognize the effects of heat and movement of heat	
Explain natural phenomena related to sound and light transmission (e.g., reflection, refraction, optical devices)	Sounds & light
Identify the effects of geological processes on Earth's surface and explain the formation of igneous and metamorphic rocks	Geological phenomena
Recognize the risks associated with geological processes and how to avoid those risks	
Know the vital functions of living things (autotrophic and heterotrophic nutrition, types of reproduction, and interaction)	Ecosystems
Identify the biotic and abiotic components of an ecosystem, diagram trophic relationships, identify Earth's major biomes, and recognize the importance of preserving ecosystems	

9.2.9.3 Physics

Topics	Subject
Particle kinematics and dynamics in more than one dimension: reference frames, position, vector, trajectory equations, displacement, average velocity, instantaneous velocity, average acceleration and instantaneous acceleration	Mechanics

vectors, motion equations, tangential and radial acceleration, Newton's Second Law, circular motion	
Motion under the action of a constant force: importance of motion initial conditions, motion equations, projectile motion	
Applying Newton's Laws: objects connected by a cord, car in a banked circular turn, vertical circular loop, static frictional force and kinetic frictional force	
Hooke's Law, simple harmonic motion (period, frequency and angular frequency, displacement from equilibrium and amplitude), velocity and acceleration in SHM, energy of a simple harmonic oscillator, and damped oscillations	
Center of mass (extended object and system of particles), velocity and acceleration of the CM, linear momentum (particle and system of particles), momentum and Newton's second Law, conservation of linear momentum, elastic and inelastic collisions	
Hydrostatic: density, pressure, variation of pressure with depth, Pascal's Law, buoyant force, Archimedes' Principle, floating objects equilibrium Fluid dynamics: steady flow, equation of continuity, Bernoulli's equation, viscosity	
Kepler's Laws, Newton's law of gravitation, gravitational constant and Cavendish experiment, gravitational field, gravitational force and weight, gravitational potential energy, orbital speed, escape speed	
Coulomb's law and electric fields: charge conservation, conductors and insulators, charging objects by induction and by contact, polarization, Coulomb's law and its similarity to Newton's laws, electric field, properties of conductors in electrostatic equilibrium	Electricity and magnetism
Electrical potential: electric potential energy, electric potential, equipotential surfaces, capacitors	
Electric current: microscopic model of current, current and potential difference, resistance and resistivity, Ohm's law	
Energy in electrical circuits: Joule's law, electromotive force and total power output of a battery, internal resistance of a battery and power delivered to the external load resistance, terminal voltage of a battery, electromotive force of a motor, internal resistance of a motor, terminal voltage of a motor	
Electric circuits equations: resistors in series and parallel, applying Ohm's law to circuits with batteries, motors and resistors, R-C circuits	

Sources of magnetic fields, magnetic field lines, magnetic force acting on a charge moving in a magnetic field, motion of charged particles in crossed electric and magnetic fields, Thomson's experiment, mass spectrometer, cyclotrons, magnetic force on a current-carrying wire, and Earth's magnetic field	
Relative motion: inertial frames and accelerated frames, the principle of Galilean relativity, Galilean transformation equations	Modern physics
Einstein's relativity: postulates of special theory of relativity, relativity of simultaneity, time dilation and length contraction, rest energy of a particle, general theory of relativity (curvature of space-time, principle of equivalence	
Planck's energy quantization, Einstein theory of light, wave-matter duality for light, ionizing and non-ionizing radiations, photoelectric effect, Compton scattering, X-rays, wave-matter duality for matter, De Broglie wavelength, and Heisenberg's principle	
Nuclear binding energy and nuclear stability, natural radioactivity, alpha, beta and gamma emission, law of radioactive decay, half-life and mean life, activity, biological effects of radioactive emissions, absorbed dose and dose equivalent, ionizing radiation detectors, applications of ionizing radiations, and nuclear reactions (nuclear fusion and nuclear fission)	

9.2.10 The Netherlands

Subjects of interest are Mathematics, Man and nature.

9.2.10.1 Mathematics

Topics	Subject
The pupil learns to use appropriate mathematical language to structure his own thoughts and to explain the matter to others, and learns to understand the mathematical language of others.	Mathematics
Independently as well as together with others, the pupil learns to recognise maths in practical situations and use it to solve problems.	
The pupil learns to set up mathematical argumentation and distinguish it from opinions and allegations, and learns to give and receive criticism while respecting other people's ways of thinking.	
The pupil learns to understand the structure and coherence of positive and negative numbers, decimal numbers, fractions, percentages and	

proportions, and learns to use these in meaningful and practical situations.	
The pupil learns to calculate exactly and by estimation and reason based on insight, accurately, in the correct order of magnitude, and using margins that are appropriate to the particular situation.	
The pupil learns to measure, learns to understand the structure and coherence of the metric system, and learns to calculate using measures and quantities that are common in relevant applications.	
The pupil learns to use informal notations, schematic images, tables, diagrams, and formulas in order to get a grip on the relationships between quantities and variables.	
The pupil learns to work with forms and structures in two as well as three dimensions, learns to create images of these and interpret them, and learns to calculate and reason using their characteristics and measurements.	
The pupil learns to systematically describe structure and visualise data, and learns to critically assess data, representations and conclusions.	

9.2.10.2 Man and nature

Topics	Subject
The pupil learns to turn questions about physical, technological and care-related subjects into research questions, carry out research about such subjects, and give a presentation of the results.	Man and Nature
The pupil learns to acquire knowledge about and insight into key concepts in living and non-living nature, and learns to relate these key concepts to situations from everyday life.	
The pupil learns to acquire knowledge about and insight into key concepts in living and non-living nature, and learns to relate these key concepts to situations from everyday life.	
The pupil learns that humans, animals and plants are interrelated with each other and their environment, and that technological and physical applications may influence both positively and negatively the sustainable quality of the environment.	
In various ways, for example by carrying out practical work, the pupil learns to acquire knowledge about and insight into processes in living and non-living nature and their relationships with the environment.	

The pupil learns to work with theories and models by carrying out research into physical and chemical phenomena, such as electricity, sound, light, movement, energy and matter.	
By carrying out research, the pupil learns to acquire knowledge about technical products and systems that are relevant to him, and learns to assess this knowledge, and design and make a technical product in a structured manner.	
The pupil learns to understand the essentials about build and function of the human body, link these to the promotion of physical and emotional health, and learns to take his own responsibility in this.	
The pupil learns about care and learns to care for himself, for others and for his environment, and learns how to positively influence his own safety and that of others in different living situations (living, learning, working, going out, traffic).	

9.2.11 UK

Subjects of interest are Mathematics, Biology and Chemistry.

9.2.11.1 Mathematics

Topics	Subject
Through the mathematics content, pupils are taught to: • develop fluency ♣ • consolidate their numerical and mathematical capability from key stage 2 and extend their understanding of the number system and place value to include decimals, fractions, powers and roots • select and use appropriate calculation strategies to solve increasingly complex problems • use algebra to generalise the structure of arithmetic, including to formulate mathematical relationships • substitute values in expressions, rearrange and simplify expressions, and solve equations • move freely between different numerical, algebraic, graphical and diagrammatic representations [for example, equivalent fractions, fractions and decimals, and equations and graphs] • develop algebraic and graphical fluency, including understanding linear and simple quadratic functions. • use language and properties precisely to analyse numbers, algebraic expressions,	Mathematical reasoning

2-D and 3-D shapes, probability and statistics.	
develop their mathematical knowledge, in part through solving problems and evaluating the outcomes, including multi-step problems • develop their use of formal mathematical knowledge to interpret and solve problems, including in financial mathematics • begin to model situations mathematically and express the results using a range of formal mathematical representations ♣ • select appropriate concepts, methods and techniques to apply to unfamiliar and no routine problems.	Problem solving
Pupils are taught to: • understand and use place value for decimals, measures and integers of any size • order positive and negative integers, decimals and fractions; use the number line as a model for ordering of the real numbers; use the symbols =, ≠, , ≤, ≥ • use the concepts and vocabulary of prime numbers, factors (or divisors), multiples, common factors, common multiples, highest common factor, lowest common multiple, prime factorisation, including using product notation and the unique factorisation property Mathematics • use the four operations, including formal written methods, applied to integers, decimals, proper and improper fractions, and mixed numbers, all both positive and negative • use conventional notation for the priority of operations, including brackets, powers, roots and reciprocals • recognise and use relationships between operations including inverse operations • use integer powers and associated real roots (square, cube and higher), recognise powers of 2, 3, 4, 5 and distinguish between exact representations of roots and their decimal approximations • interpret and compare numbers in standard form A x 10n 1≤A	Numbers
Pupils are taught to: • use and interpret algebraic notation, including: • ab in place of a × b • 3y in place of y + y + y and 3 × y • a2 in place of a × a, a3 in place of a × a × a; a2 b in place of a × a × b	Algebra

• b a in place of a ÷ b • coefficients written as fractions rather than as decimals • brackets • substitute numerical values into formulae and expressions, including scientific formulae Mathematics • understand and use the concepts and vocabulary of expressions, equations, inequalities, terms and factors • simplify and manipulate algebraic expressions to maintain equivalence by: • collecting like terms • multiplying a single term over a bracket • taking out common factors • expanding products of two or more binomials • understand and use standard mathematical formulae; rearrange formulae to change the subject • model situations or procedures by translating them into algebraic expressions or formulae and by using graphs • use algebraic methods to solve linear equations in one variable (including all forms that require rearrangement) • work with coordinates in all four quadrants • recognise, sketch and produce graphs of linear and quadratic functions of one variable with appropriate scaling, using equations in x and y and the Cartesian plane • interpret mathematical relationships both algebraically and graphically • reduce a given linear equation in two variables to the standard form y = mx + c; calculate and interpret gradients and intercepts of graphs of such linear equations numerically, graphically and algebraically • use linear and quadratic graphs to estimate values of y for given values of x and vice versa and to find approximate solutions of simultaneous linear equations • find approximate solutions to contextual problems from given graphs of a variety of functions, including piece-wise linear, exponential and reciprocal graphs • generate terms of a sequence from either a term-to-term or a position-to-term rule • recognise arithmetic sequences and find the nth term • recognise geometric sequences and appreciate other sequences that arise	

Pupils are taught to: • change freely between related standard units [for example time, length, area, volume/capacity, mass] • use scale factors, scale diagrams and maps • express one quantity as a fraction of another, where the fraction is less than 1 and greater than 1 • use ratio notation, including reduction to simplest form Mathematics • divide a given quantity into two parts in a given part:part or part:whole ratio; express the division of a quantity into two parts as a ratio • understand that a multiplicative relationship between two quantities can be expressed as a ratio or a fraction • relate the language of ratios and the associated calculations to the arithmetic of fractions and to linear functions • solve problems involving percentage change, including: percentage increase, decrease and original value problems and simple interest in financial mathematics • solve problems involving direct and inverse proportion, including graphical and algebraic representations • use compound units such as speed, unit pricing and density to solve problems.	Ratio, proportion and rates of change
Pupils should be taught to: • derive and apply formulae to calculate and solve problems involving: perimeter and area of triangles, parallelograms, trapezia, volume of cuboids (including cubes) and other prisms (including cylinders) • calculate and solve problems involving: perimeters of 2-D shapes (including circles), areas of circles and composite shapes • draw and measure line segments and angles in geometric figures, including interpreting scale drawings • derive and use the standard ruler and compass constructions (perpendicular bisector of a line segment, constructing a perpendicular to a given line from/at a given point, bisecting a given angle); recognise and use the perpendicular distance from a point to a line as the shortest distance to the line • describe, sketch and draw using conventional terms and notations: points, lines, parallel lines, perpendicular lines,	Geometry and measures

right angles, regular polygons, and other polygons that are reflectively and rotationally symmetric • use the standard conventions for labelling the sides and angles of triangle ABC, and know and use the criteria for congruence of triangle derive and illustrate properties of triangles, quadrilaterals, circles, and other plane figures [for example, equal lengths and angles] using appropriate language and technologies • identify properties of, and describe the results of, translations, rotations and reflections applied to given figures • identify and construct congruent triangles, and construct similar shapes by enlargement, with and without coordinate grids • apply the properties of angles at a point, angles at a point on a straight line, vertically opposite angles • understand and use the relationship between parallel lines and alternate and corresponding angles Mathematics • derive and use the sum of angles in a triangle and use it to deduce the angle sum in any polygon, and to derive properties of regular polygons • apply angle facts, triangle congruence, similarity and properties of quadrilaterals to derive results about angles and sides, including Pythagoras' Theorem, and use known results to obtain simple proofs • use Pythagoras' Theorem and trigonometric ratios in similar triangles to solve problems involving right-angled triangles • use the properties of faces, surfaces, edges and vertices of cubes, cuboids, prisms, cylinders, pyramids, cones and spheres to solve problems in 3-D • interpret mathematical relationships both algebraically and geometrically	
Pupils are taught to: • record, describe and analyse the frequency of outcomes of simple probability experiments involving randomness, fairness, equally and unequally likely outcomes, using appropriate language and the 0-1 probability scale • understand that the probabilities of all possible outcomes sum to 1	Probability

• enumerate sets and unions/intersections of sets systematically, using tables, grids and Venn diagrams • generate theoretical sample spaces for single and combined events with equally likely, mutually exclusive outcomes and use these to calculate theoretical probabilities.	
Pupils should be taught to: • describe, interpret and compare observed distributions of a single variable through: appropriate graphical representation involving discrete, continuous and grouped data; and appropriate measures of central tendency (mean, mode, median) and spread (range, consideration of outliers) • construct and interpret appropriate tables, charts, and diagrams, including frequency tables, bar charts, pie charts, and pictograms for categorical data, and vertical line (or bar) charts for ungrouped and grouped numerical data • describe simple mathematical relationships between two variables (bivariate data) in observational and experimental contexts and illustrate using scatter graphs.	Statistics

9.2.11.2 Biology

Topics	Subject
Students are helped to understand how, through the ideas of biology, the complex and diverse phenomena of the natural world can be described in terms of a number of key ideas which are of universal application, and which can be illustrated in the separate topics set out below. Students are taught about: • cells as the basic structural unit of all organisms; adaptations of cells related to their functions; the main sub-cellular structures of eukaryotic and prokaryotic cells • stem cells in animals and meristems in plants • enzymes • factors affecting the rate of enzymatic reactions • the importance of cellular respiration; the processes of aerobic and anaerobic respiration	Cells

• carbohydrates, proteins, nucleic acids and lipids as key biological molecules • the need for transport systems in multicellular organisms, including plants • the relationship between the structure and functions of the human circulatory system.	
• the relationship between health and disease • communicable diseases including sexually transmitted infections in humans (including HIV/AIDs) • non-communicable diseases Science • bacteria, viruses and fungi as pathogens in animals and plants • body defences against pathogens and the role of the immune system against diseases • reducing and preventing the spread of infectious diseases in animals and plants • the process of discovery and development of new medicines • the impact of lifestyle factors on the incidence of non-communicable diseases.	Diseases, bacteria, viruses
• principles of nervous coordination and control in humans • the relationship between the structure and function of the human nervous system • the relationship between structure and function in a reflex arc • principles of hormonal coordination and control in humans	Nervous system
• principles of hormonal coordination and control in humans • hormones in human reproduction, hormonal and non-hormonal methods of contraception • homeostasis.	Hormones
• photosynthesis as the key process for food production and therefore biomass for life • the process of photosynthesis • factors affecting the rate of photosynthesis.	Photosynthesis
• levels of organisation within an ecosystem • some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community • how materials cycle through abiotic and biotic components of ecosystems	Ecosystems

• the role of microorganisms (decomposers) in the cycling of materials through an ecosystem • organisms are interdependent and are adapted to their environment • the importance of biodiversity • methods of identifying species and measuring distribution, frequency and abundance of species within a habitat • positive and negative human interactions with ecosystems. • the genome as the entire genetic material of an organism • how the genome, and its interaction with the environment, influence the development of the phenotype of an organism • the potential impact of genomics on medicine • most phenotypic features being the result of multiple, rather than single, genes • single gene inheritance and single gene crosses with dominant and recessive phenotypes	
• sex determination in humans • genetic variation in populations of a species • the process of natural selection leading to evolution • the evidence for evolution • developments in biology affecting classification • the importance of selective breeding of plants and animals in agriculture • the uses of modern biotechnology including gene technology; some of the practical and ethical considerations of modern biotechnology.	Human reproduction

9.2.11.3 Chemistry

Topics	Subject
Students are taught about: • a simple model of the atom consisting of the nucleus and electrons, relative atomic mass, electronic charge and isotopes • the number of particles in a given mass of a substance • the modern Periodic Table, showing elements arranged in order of atomic number	Atomic structure and the Periodic Table

• position of elements in the Periodic Table in relation to their atomic structure and arrangement of outer electrons • properties and trends in properties of elements in the same group • characteristic properties of metals and non-metals • chemical reactivity of elements in relation to their position in the Periodic Table	
• changes of state of matter in terms of particle kinetics, energy transfers and the relative strength of chemical bonds and intermolecular forces • types of chemical bonding: ionic, covalent, and metallic • bulk properties of materials related to bonding and intermolecular forces • bonding of carbon leading to the vast array of natural and synthetic organic compounds that occur due to the ability of carbon to form families of similar compounds, chains and rings • structures, bonding and properties of diamond, graphite, fullerenes and graphene.	Structure, bonding and the properties of matter
• determination of empirical formulae from the ratio of atoms of different kinds • balanced chemical equations, ionic equations and state symbols • identification of common gases • the chemistry of acids; reactions with some metals and carbonates • pH as a measure of hydrogen ion concentration and its numerical scale • electrolysis of molten ionic liquids and aqueous ionic solutions • reduction and oxidation in terms of loss or gain of oxygen. • energy changes in chemistry • measurement of energy changes in chemical reactions (qualitative) • bond breaking, bond making, activation energy and reaction profiles (qualitative) • rate and extent of chemical change • factors that influence the rate of reaction: varying temperature or concentration, changing the surface area of a solid reactant or by adding a catalyst • factors affecting reversible reactions.	Chemical changes
• distinguishing between pure and impure substances • separation techniques for mixtures of substances: filtration, crystallisation, chromatography, simple and fractional distillation	Chemical analysis

• quantitative interpretation of balanced equations • concentrations of solutions in relation to mass of solute and volume of solvent.	
• life cycle assessment and recycling to assess environmental impacts associated with all the stages of a product's life • the viability of recycling of certain materials • carbon compounds, both as fuels and feedstock, and the competing demands for limited resources • fractional distillation of crude oil and cracking to make more useful materials • extraction and purification of metals related to the position of carbon in a reactivity series.	Chemical and allied industries
• evidence for composition and evolution of the Earth's atmosphere since its formation • evidence, and uncertainties in evidence, for additional anthropogenic causes of climate change • potential effects of, and mitigation of, increased levels of carbon dioxide and methane on the Earth's climate • common atmospheric pollutants: sulphur dioxide, oxides of nitrogen, particulates and their sources • the Earth's water resources and obtaining potable water	Earth and atmospheric science

9.2.11.4 Physics

Topics	Subject
Students are taught about: • a simple model of the atom consisting of the nucleus and electrons, relative atomic mass, electronic charge and isotopes • the number of particles in a given mass of a substance • the modern Periodic Table, showing elements arranged in order of atomic number • position of elements in the Periodic Table in relation to their atomic structure and arrangement of outer electrons • properties and trends in properties of elements in the same group • characteristic properties of metals and non-metals	Atomic structure and the Periodic Table

• chemical reactivity of elements in relation to their position in the Periodic Table	
• changes of state of matter in terms of particle kinetics, energy transfers and the relative strength of chemical bonds and intermolecular forces • types of chemical bonding: ionic, covalent, and metallic • bulk properties of materials related to bonding and intermolecular forces • bonding of carbon leading to the vast array of natural and synthetic organic compounds that occur due to the ability of carbon to form families of similar compounds, chains and rings • structures, bonding and properties of diamond, graphite, fullerenes and graphene.	Structure, bonding and the properties of matter
• determination of empirical formulae from the ratio of atoms of different kinds • balanced chemical equations, ionic equations and state symbols • identification of common gases • the chemistry of acids; reactions with some metals and carbonates • pH as a measure of hydrogen ion concentration and its numerical scale • electrolysis of molten ionic liquids and aqueous ionic solutions • reduction and oxidation in terms of loss or gain of oxygen. • energy changes in chemistry • measurement of energy changes in chemical reactions (qualitative) • bond breaking, bond making, activation energy and reaction profiles (qualitative) • rate and extent of chemical change • factors that influence the rate of reaction: varying temperature or concentration, changing the surface area of a solid reactant or by adding a catalyst • factors affecting reversible reactions.	Chemical changes
• distinguishing between pure and impure substances • separation techniques for mixtures of substances: filtration, crystallisation, chromatography, simple and fractional distillation • quantitative interpretation of balanced equations • concentrations of solutions in relation to mass of solute and volume of solvent.	Chemical analysis
• the nuclear model and its development in the light of changing evidence	Atomic structure

• masses and sizes of nuclei, atoms and small molecules • differences in numbers of protons and neutrons related to masses and identities of nuclei; isotope characteristics and equations to represent changes • ionisation; absorption or emission of radiation related to changes in electron orbits • radioactive nuclei; emission of alpha or beta particles, neutrons, or gamma-rays, related to changes in the nuclear mass and/or charge • radioactive materials, half-life, irradiation, contamination and their associated hazardous effects; waste disposal • nuclear fission, nuclear fusion and our Sun's energy	
• the main features of the solar system	Space physics

Subject content – Physics

Physics is the science of the fundamental concepts of field, force, radiation and particle structures, which are inter-linked to form unified models of the behaviour of the material universe. From such models, a wide range of ideas, from the broadest issue of the development of the universe over time to the numerous and detailed ways in which new technologies may be invented, have emerged. These have enriched both our basic understanding of, and our many adaptations to, our material environment. Students should be helped to understand how, through the ideas of physics, the complex and diverse phenomena of the natural world can be described in terms of a number of key ideas which are of universal application and which can be illustrated in the separate topics set out below. These ideas include: ♣ the use of models, as in the particle model of matter or the wave models of light and of sound ♣ the concept of cause and effect in explaining such links as those between force and acceleration, or between changes in atomic nuclei and radioactive emissions ♣ the phenomena of 'action at a distance' and the related concept of the field as the key to analysing electrical, magnetic and gravitational effects ♣ that differences, for example between pressures or temperatures or electrical potentials, are the drivers of change ♣ that proportionality, for example between weight and mass of an object or between force and extension in a spring, is an important aspect of many models in science. Students should be taught about:

Energy ♣ energy changes in a system involving heating, doing work using forces, or doing work using an electric current; calculating the stored energies and energy changes involved Science 78 ♣ power as the rate of transfer of energy ♣ conservation of energy in a closed system; dissipation ♣ calculating energy efficiency for any energy transfers ♣ renewable and non-renewable energy sources used on Earth; changes in how these are used.

Forces ♣ forces and fields: electrostatic, magnetic, gravity ♣ forces as vectors ♣ calculating work done as force x distance; elastic and inelastic stretching ♣ pressure in fluids acts in all directions: variation in Earth's atmosphere with height, with depth for liquids, up-thrust force (qualitative).

Forces and motion ♣ speed of sound; estimating speeds and accelerations in everyday contexts ♣ interpreting quantitatively graphs of distance, time, and speed ♣ acceleration caused by forces; Newton's First Law ♣ weight and gravitational field strength ♣ decelerations and braking distances involved on roads.

Wave motion ♣ amplitude, wavelength and frequency; relating velocity to frequency and wavelength ♣ transverse and longitudinal waves ♣ electromagnetic waves and their velocity in vacuum; waves transferring energy; wavelengths and frequencies from radio to gamma-rays ♣ velocities differing between media: absorption, reflection, refraction effects ♣ production and detection, by electrical circuits, or by changes in atoms and nuclei ♣ uses in the radio, microwave, infra-red, visible, ultra-violet, X-ray and gamma-ray regions, hazardous effects on bodily tissues.

Electricity ♣ measuring resistance using p.d. and current measurements ♣ exploring current, resistance and voltage relationships for different circuit elements, including their graphical representations Science 79 ♣ quantity of charge flowing as the product of current and time ♣ drawing circuit diagrams; exploring equivalent resistance for resistors in series ♣ the domestic a.c. supply; live, neutral and earth mains wires; safety measures ♣ power transfer related to p.d. and current, or current and resistance.

Magnetism and electromagnetism ♣ exploring the magnetic fields of permanent and induced magnets, and the Earth's magnetic field, using a compass ♣ magnetic effects of currents; how solenoids enhance the effect ♣ how transformers are used in the national grid and the reasons for their use.

The structure of matter ♣ relating models of arrangements and motions of the molecules in solid, liquid and gas phases to their densities ♣ melting, evaporation, and sublimation as reversible changes ♣ calculating energy changes involved on heating, using specific heat capacity; and those involved in changes of state, using specific latent heat ♣ links between pressure and temperature of a gas at constant volume, related to the motion of its particles (qualitative).

Atomic structure

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